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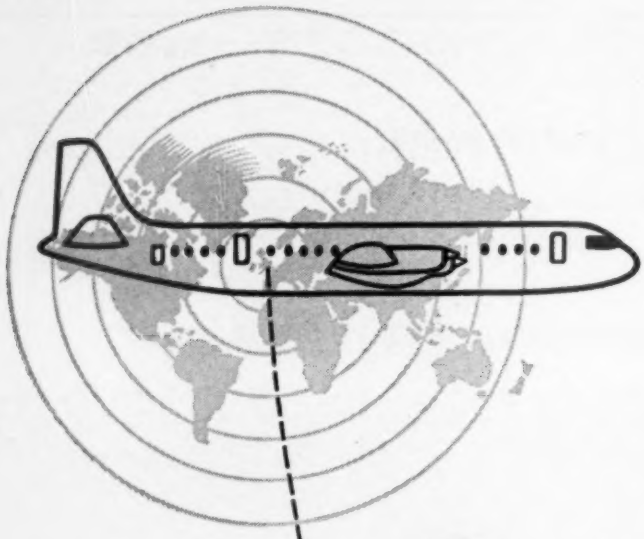

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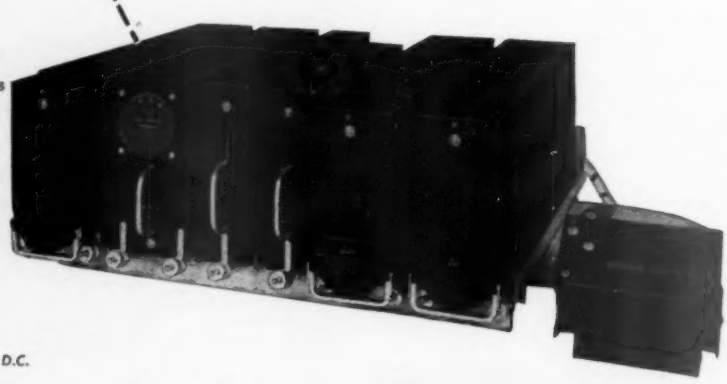

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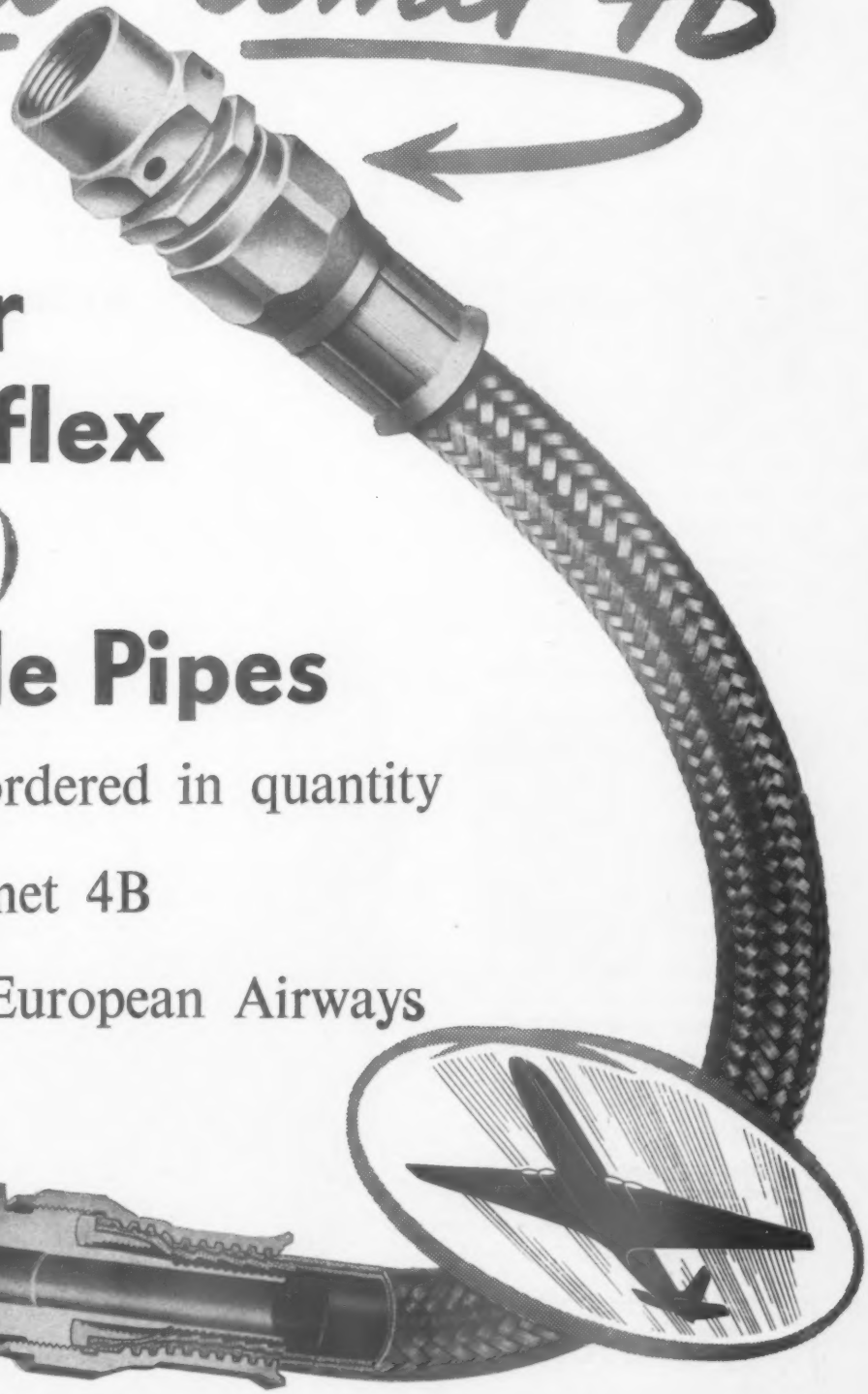

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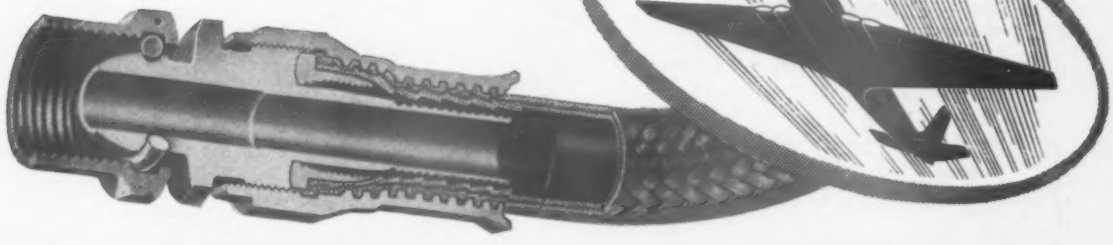

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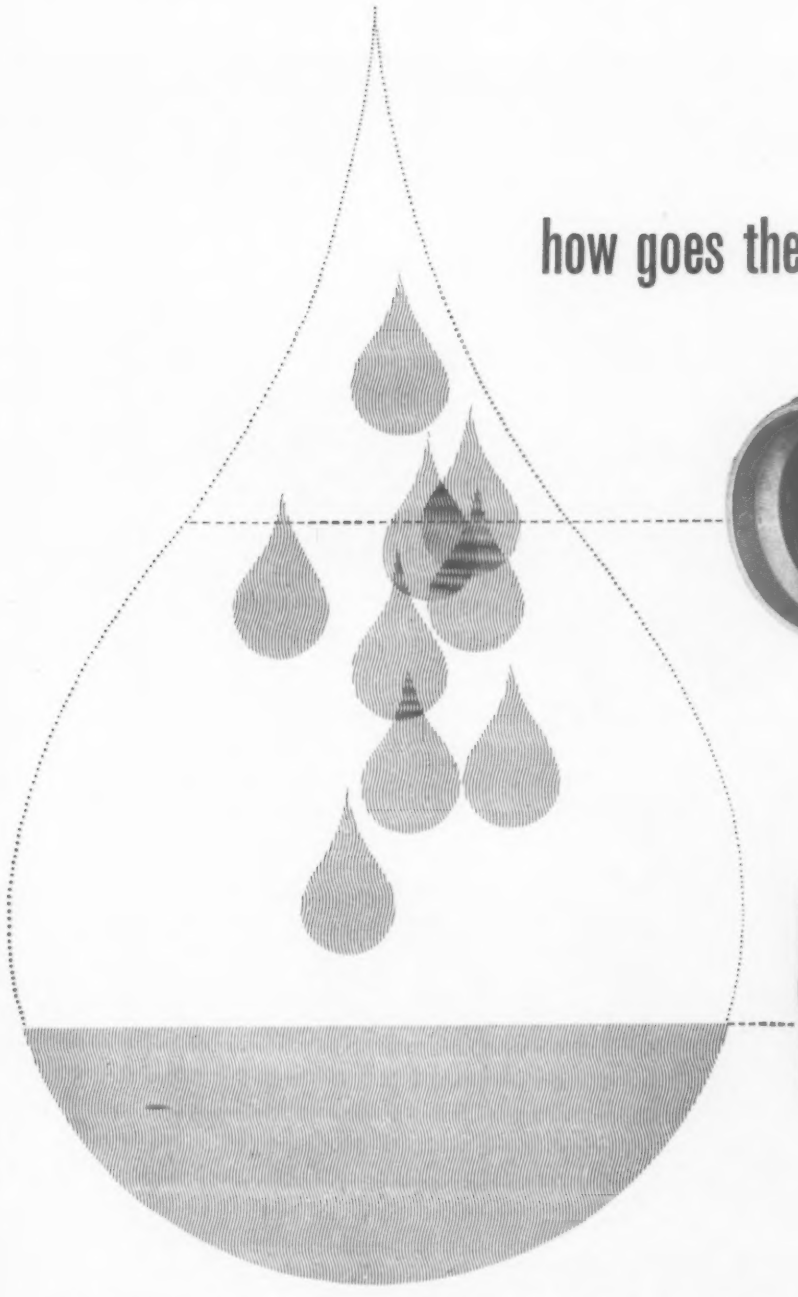

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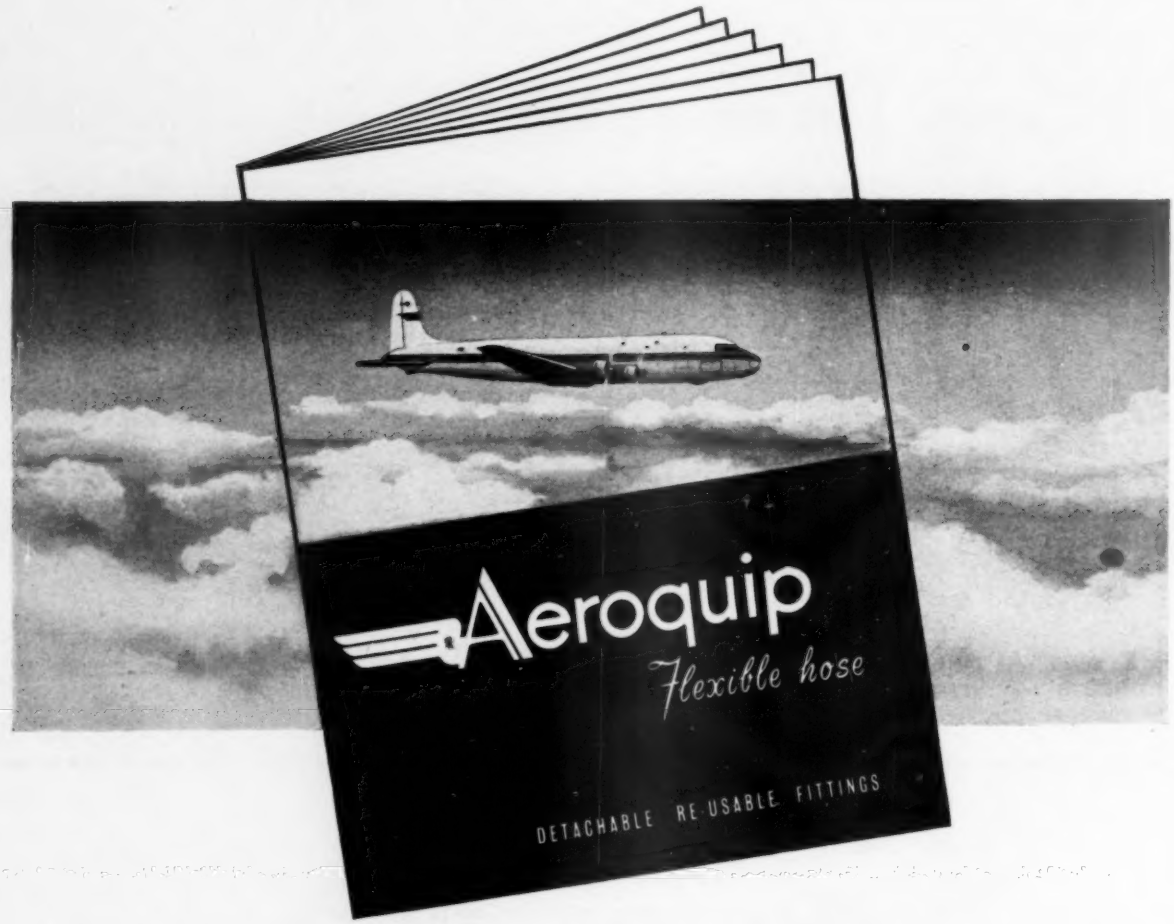

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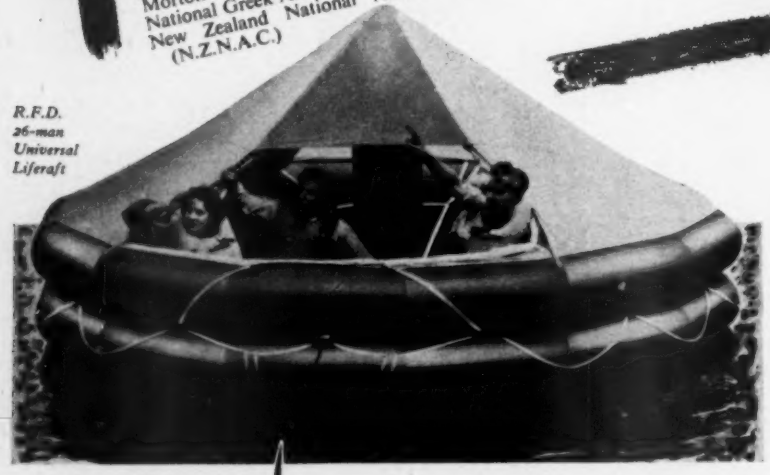

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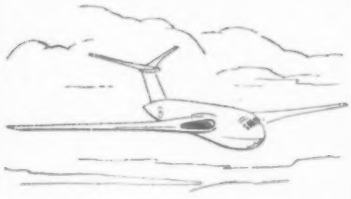

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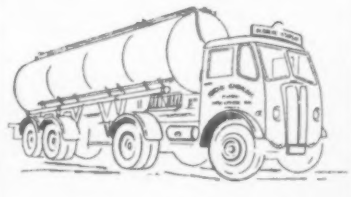

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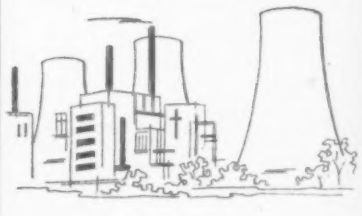

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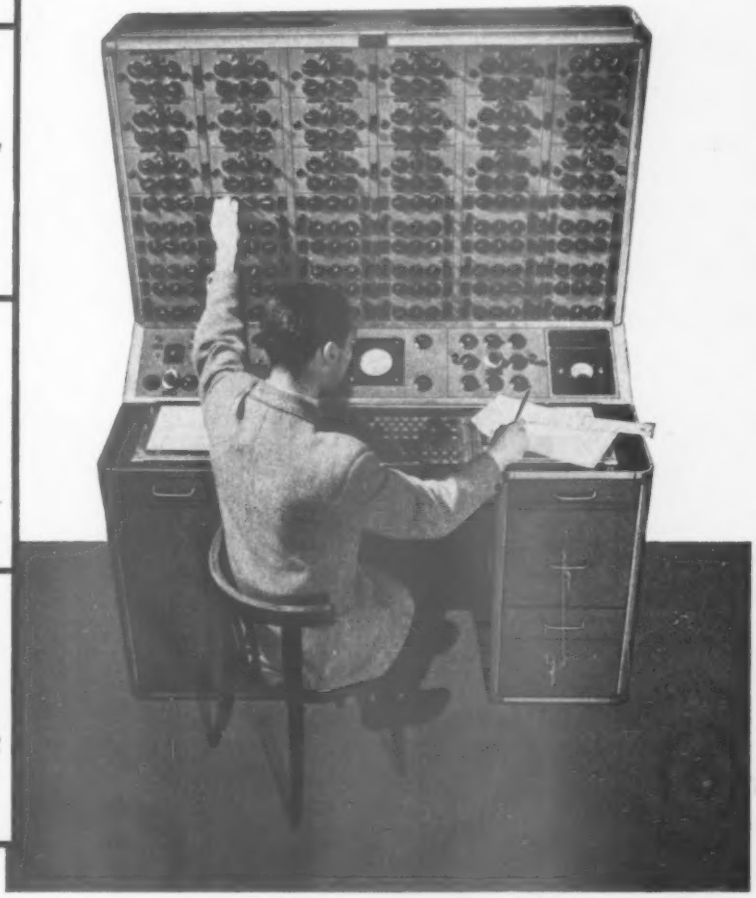

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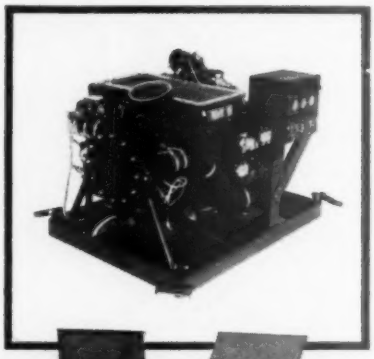

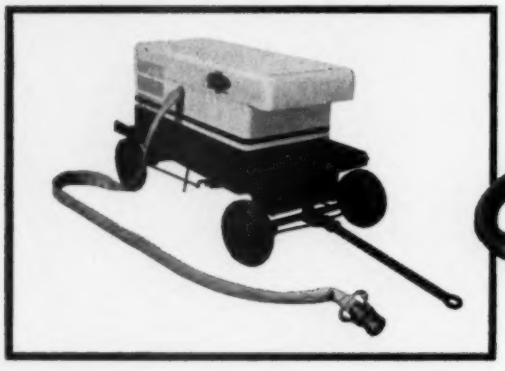

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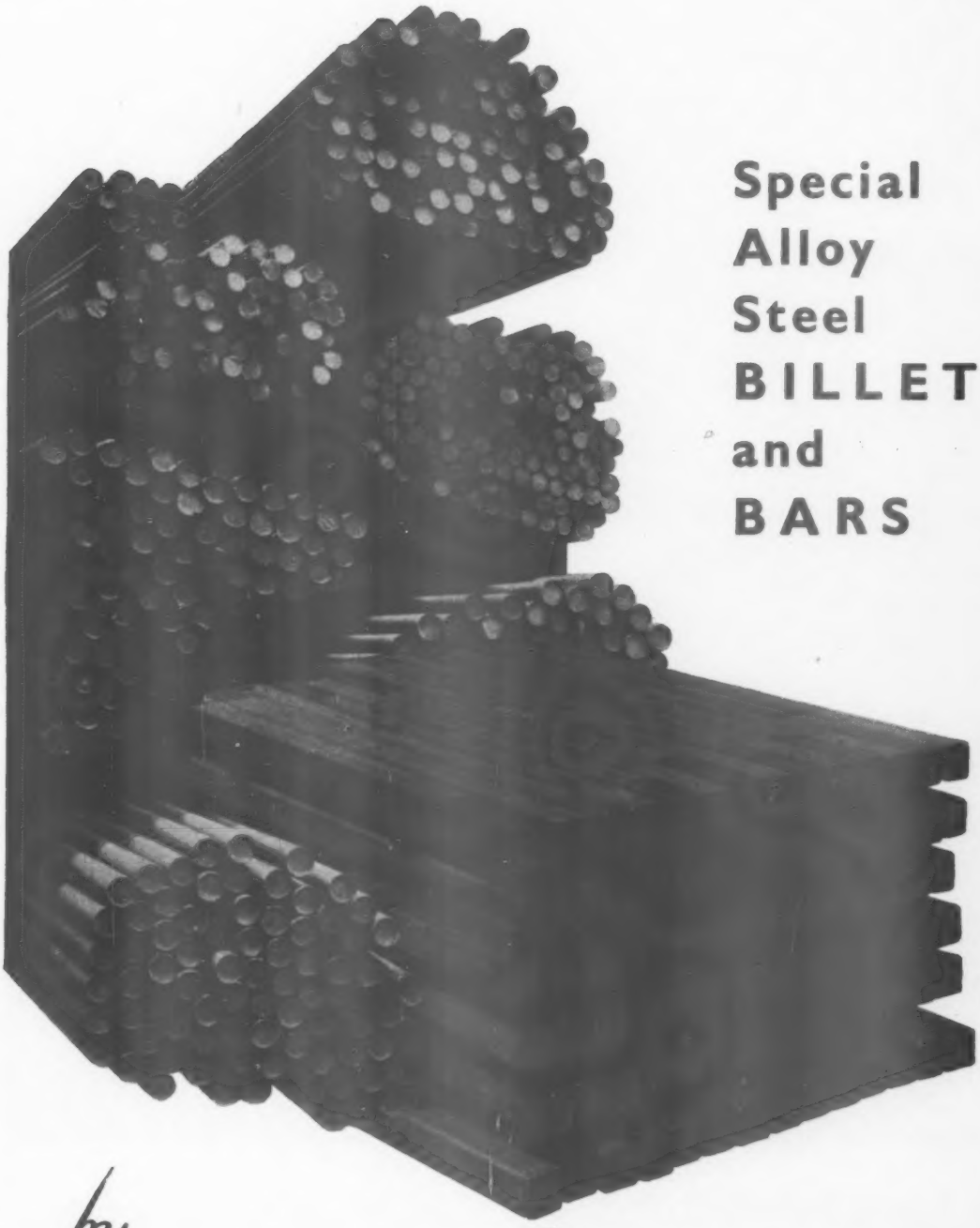

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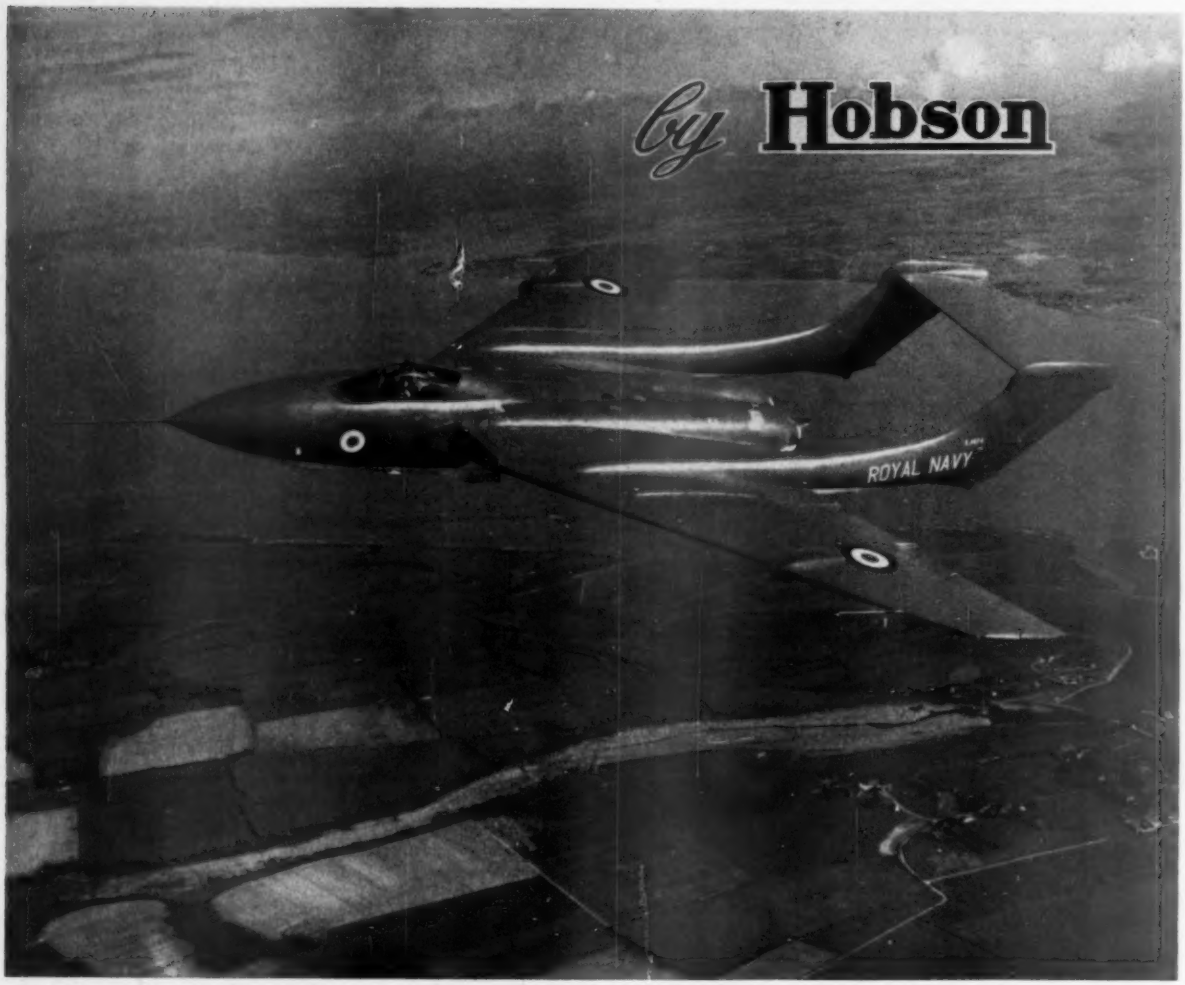

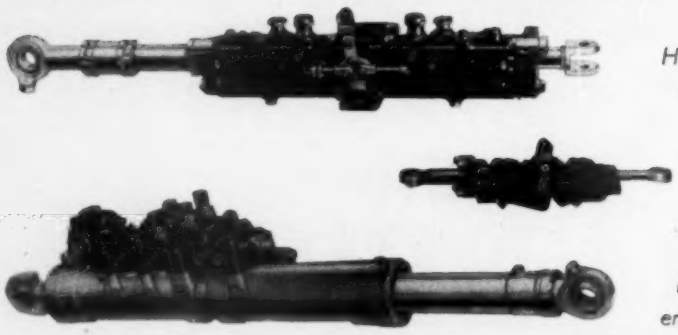

HOBSON POWER FLYING CONTROLS are being produced for a number of British aircraft, including those incorporating "All-flying" or "Slab" tailplanes. The units illustrated here are typical double-acting tandem-piston type jacks, having duplicated hydraulic control systems.

HOBSON tandem-piston jacks of similar design are employed on the three primary control surfaces of the de Havilland "Sea Vixen" all-weather naval fighter.

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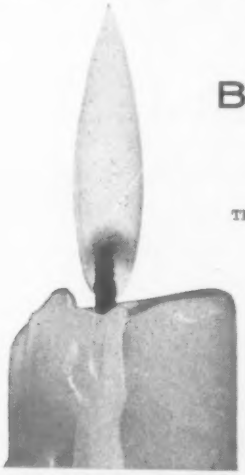

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Fairey's Rotodyne vertical take-off airliner has established itself as the fastest rotorcraft in the world. On 5th January, 1959, it flew round a 62 mile closed-circuit record course at an officially observed average speed of 191 m.p.h. for a new world convertiplane speed record—at *cruising* power and *operational* weight.

This record, almost 50 m.p.h. faster than the corresponding helicopter record and 30 m.p.h. faster than the absolute speed record for helicopters, confirms Fairey's claim that the true V.T.O. airliner is here, now, for city-centre to city-centre journeys, needing no expensive airfields, wasting no valuable time.

FAIREY *Rotodyne*

Powered by Napier Eland turbo-props

THE FAIREY AVIATION COMPANY LIMITED HAYES · MIDDLESEX

ENGLAND · AUSTRALIA · CANADA

THE AEROPLANE

Incorporating
Aeronautical Engineering
Edited by - - THURSTAN JAMES

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IS A SUPERSONIC VENTURE JUSTIFIED?

AT long last the Civil Supersonic Airliner Committee has submitted its report, said to run into the better part of 300 pages, to the Minister of Supply. It was Mr. Aubrey Jones himself who announced this fact and himself who, almost in the same breath, said he had not yet had time to study it.

Who cares about a supersonic airliner, we wonder? The Air Ministry some time ago cancelled their interest in a supersonic bomber in spite of the fact that manned scale models were well on the way to completion. We hear a good many rumbles, more or less *sotto voce*, from the Navy and the Army regarding their own uninhibited desires in the realm of aeronautics, but we have never heard mention of a supersonic air transport. If the Ministry of Transport and Civil Aviation is an enthusiast for supersonic air transport, we have yet to hear of it. In the industry itself there is no unanimous voice. We ourselves have consistently argued in favour of a national effort to build a supersonic transport.

Construction of such a vehicle is quite clearly one of those things which must happen somewhere in the World and we believe it should happen in this country too. Moreover, and this was the cogent reason to our way of thinking, the official decision vouchsafed in the Defence White Paper of 1957 to drop the development of manned military high-performance aircraft meant that the only practical justification for officially sponsored research and development would be a nationally co-ordinated scheme to build a supersonic world-beater.

Since those days a lot of supersonic air has vanished down the wind-tunnels of the World's research laboratories. Ideas, if not crystal clear, are at least much less shapeless than they were. And so far as British military aviation is concerned the pendulum is no longer hard to one side: it has started to swing again. New military manned aeroplanes of high performance for the Royal Air Force are not only being talked about, they have been ordered and are being built.

In such circumstances the building of the supersonic airliner no longer offers the only way to obtain State support for aeronautical development work. Research will be necessary to ensure the development of the new generation of military aircraft, with all the cross-fertilization that that involves for civil design. Consequently there is bound to be a good deal of heart-searching before an enormous expenditure is sanctioned on research for a supersonic airliner. In this context it is right to note that a sum of £100 million has been mentioned as the cost of bringing a supersonic airliner to the stage of availability for airline use. Many people think it will be much more. Figures five times that sum have been mentioned.

The next point that has to be considered is how fast does a transport have to travel before it can be classed as supersonic? There are those who argue that a cruising speed of Mach=1.2 might be satisfactory. It is even thought that at this speed B.E.A. might be able to show a saving by using such machines on stages over 1,000 miles. The most popular speed is thought by people in this country to be around Mach=1.8. In stark contrast with these modest figures the U.S. Aircraft Industry is talking about going all out for a machine able to cruise at Mach=3.

It is as well at this stage to recall the peculiar feature of the supersonic air transport. Its ability to fly long stages, such as those across the Atlantic, in two or three hours will result in a very high productive capacity, i.e. a single machine will be able to generate such a high seat-miles capacity figure that one 135-passenger supersonic airliner may well equal four Boeing 707 or equivalent, subsonic jetliners. The World market for such costly machines will be strictly limited.

How at this stage is the country to get advice on whether to go for a space-exploration programme with Blue Streak or to keep out of space and organize a co-operative national venture to build a supersonic airliner? Moreover, it is clear that it is not much good going for the Mach=1.2 or Mach=1.8 machines. If we do produce such a machine it will be overshadowed by the U.S. contender of Mach=3. There seems no shadow of doubt that that is the sort of performance American constructors have in mind.

In the recent debates on Service Estimates various members have aired points of view regarding the future of the Ministry of Supply. In addition, there are those who wish to see the Civil Aviation side of M.T.C.A. go back to the Air Ministry. There are even enthusiasts who feel that we shall never make real progress until we have a Ministry of Civil Aviation solely devoted to the work of the Corporations and Independents, and private flying and gliding. Yet somehow we feel that no further separation of interests is required. Only a clear agglomeration of air interests could result in this country having the authority it needs to plan, build and put into service the fastest supersonic air transport in the World. And at present there is no single-minded Air Authority to do this.

Matters of Moment

Supersonic Airliner Possibilities

MR. AUBREY JONES, the Minister of Supply, said on March 13 that he had received the report of the committee set up early in 1957 to investigate the economics of the supersonic airliner. Represented on the committee were government research establishments, the airline corporations and aircraft companies. A survey which discussed the problems investigated by the committee appeared in THE AEROPLANE on January 9 this year.

Mr. Jones gave no information on the recommendations made. Well informed opinion has it that the report favours an airliner flying just under Mach 2. Opinion in the U.S., on the other hand, is more in favour of a Mach 3 supersonic airliner which could be developed for service around 1970 rather than a lower-speed aircraft for earlier service. This view seems to have the general support of the airlines.

Decisions on the construction of a supersonic airliner now rest with the Government. Development costs have been estimated at £100 million and a grouping of the aircraft industry's design and development effort is likely to be essential for such a large project.

PREMIER INTEREST.—The Rt. Hon. Harold Macmillan, visited the Belfast works of Short Bros. and Harland Ltd., recently. Here he inspects a landscape model showing VTOL fighter aircraft operation. Left to right are Mr. H. G. Conway, Mr. F. H. Robertson, the Prime Minister, and Rear Admiral Sir Matthew Slattery.

The Munich Accident Report

A VERY thorough, detailed and well-documented report from the German Federal Government on the accident to the B.E.A. Elizabethan at Munich was issued by the M.T.C.A. last week. The findings of the inquiry were to the effect that a rough layer of ice on the upper surface of the wing of G-ALZU reduced aerodynamic efficiency and acceleration so that take-off speed could not be attained within the runway length available. The report added that other causes may have influenced the situation during the final phases of the attempted take-off.

The accident occurred on February 6, 1958, at 16.03 hrs. local time at Munich-Riem Airport, where the Ambassador/Elizabethan had refuelled on a flight from Belgrade to London. After two attempted take-offs—each abandoned because of boost-reading variations—the aircraft overran the boundary on a third take-off. Of the 44 occupants, 21 were killed outright and two others died later from injuries received. The captain-in-charge—who was acting during the take-off as first officer and was in the right-hand seat—survived.

The weather conditions an hour before the accident included a visibility of 1.6 n. miles, 8/8ths cloud at 600 ft., slight snowfall and a temperature which was at (later a little below) 0° C. The take-off weight was 54,540 lb.—460 lb. below the maximum. The aircraft reached V_1 speed (117 kt.), but failed to accelerate thereafter, striking a house and a wooden hut beyond the boundary. It had been on the ground at Munich for nearly two hours.

A careful examination of the situation (coupled with evidence that 16 other aircraft had taken-off normally during that afternon and evening) led the inquiry to the view that snow and slush on the runway could not have been the cause of the accident. A very good case was, however, made for the probability that melted snow had formed a 5 mm.-thick layer of ice on the supercooled skin of the wing while the aircraft was on the ground at Munich and that evaporative cooling on take-off might have been a further influence on this formation.

The report discusses in detail the possible events during the final stages of the attempted take-off, when there appears to have been an unexplained drop in speed before the brakes were (as shown by skid marks) applied. The report does not, however, suggest that this drop in speed might have been caused by surface conditions about or beyond the 5,900-ft. point on the 6,260-ft. runway.

Nor does it suggest that the skid marks might have been the result of braking the wheels as a normal part of the drill after undercarriage retraction—which was, according to the captain's evidence, initiated just before the crash. In an appendix to the report the captain states that the cause of the accident was directly connected with the deceleration, which, in his view, could not have been the result of ice on the wings.

Bread-and-Butter Transports

WHILE all the more dramatic talk just now is about supersonic and short-medium-haul high-subsonic transport prospects, another requirement—very much nearer in the development time-scale and in its bread-and-butter possibilities—is liable to be forgotten. This is for a short-haul, very big-capacity aeroplane for vehicle-ferry, or alternative holiday-coach work.

On p. 330 Silver City's plans for the use of R.A.F. Manston are described. By way of a start this aerodrome will be the base for rail-air-rail operations between London and Paris, but

STILL UNBEATEN.—On September 30, 1948, a record, still unbroken, for the fastest time (46 min. 44½ sec.) between the centres of London and Paris was set up by a team of two helicopters and one aeroplane. A reunion dinner of those concerned was held in London on March 10. Holding the R.Ae.C. certificate of performance are: Captain K. G. Bartlett, Mr. Eric Greenwood, navigator of the Gloster Meteor Mk. VII and Mr. Alan Bristow, pilot of the Westland-Sikorsky S.51 helicopter. Then right to left, Mr. Norman Hill, Mr. R. E. Dangerfield, Mr. Gerry Morel, the editor of *The Aeroplane*, Colonel Rupert Preston, secretary-general of the R.Ae.C., Mr. E. N. Adlington, Mr. T. S. Sprigg. Mr. E. A. Swiss, pilot of the Bristol 171 Mk. 1 helicopter was unable to attend and the organizers were unable to contact Sqn. Ldr. W. A. Waterton, pilot of the Gloster Meteor Mk. VII.

VICTOR TWO.—Last week, the prototype Victor B.2 was shown to the Press for the first time. An account of a visit to see the Victor production lines is on pages 327 and 328. In this demonstration the Victor was flown by Flt. Lt. J. W. Allam, Handley Page deputy chief test pilot.

Photograph copyright "The Aeroplane"

there is little doubt that, very soon, it will be used also for continuously increasing vehicle-ferry operations.

For both these types of operation a very big-capacity aircraft is needed—an aircraft without frills, which is comparatively cheap to buy and to operate, and which, possibly piston-engined and certainly propeller-driven, does not need to cruise at a particularly high speed. At present Silver City is planning to use written-down medium-long-haul Hermes for the rail-air link and will, for some time to come, continue to use Bristol 170s for the vehicle ferry. But the time must soon come when new equipment must be ordered and obviously it will be sensible to buy one aircraft type which will do both these jobs of work.

What this aircraft is likely to be is anyone's guess. It may be the projected Armstrong Whitworth 670, which can carry six cars or up to 126 passengers in a coach-class layout, or it may be something even bigger. All that can be said is that Silver City and many other operators in the World are looking, not for some £10-million supersonic transport, or even for some £2-million high-subsonic distance-killer, but just for a work-horse.

Second Black Knight Launched

BRITAIN is moving gradually into the ballistic-missile field with launchings of Black Knight re-entry research vehicles; the first was fired on September 7 last year and the second was on March 12. These firings are a prelude to the first launching tests of the Blue Streak LRBM, which will probably begin at Woomera later this year.

Black Knight launchings must play a big rôle in accustoming the Woomera personnel to the techniques of tracking ballistic missiles which will be used in Blue Streak development. Until recently Woomera has been used mainly for the development of air-to-air and surface-to-air missiles; Black Knight firings will ease the transition to the testing of long-range ballistic missiles.

Black Knight was designed by a team headed by the R.A.E.; the principal contractors are Saunders-Roe, Ltd., and Armstrong Siddeley Motors, Ltd., who have developed the engine from a design by the Rocket Propulsion Establishment at Westcott. It is a four-barrel unit known as the Gamma Mk. 201. The propellants are HTP and kerosene; engine thrust increases from 16,400 lb. at sea-level to nearly 19,000 lb. outside the Earth's atmosphere.

Black Knight is about 35 ft. long and 3 ft. in diameter. No details of its performance have been given except that on its first firing a height of 300 miles was reached and on the second it climbed 350 miles. For the first launching the target area was 60 miles from the launching point.

The flight programme for Black Knight involves a vertical climb for several thousand feet after which the vehicle is directed in a powered climb towards the target area. After power cut-off it enters a ballistic trajectory, coasting upwards to the apogee and then falling towards the target. Information on engine performance, guidance, control and external conditions are telemetered to ground stations during the missile's flight; re-entry behaviour is also recorded.

Gliding Dilemmas

EIGHT hours after the end of the highly successful Annual Ball of the British Gliding Association in the early hours of Saturday, March 14, at Londonderry House, the Annual General Meeting began. At the Ball, Mr. Peter Masefield had presented the annual trophies, already listed in THE AEROPLANE.

Re-election of Viscount Kemsley as president, Sir David Brunt as vice-president, and Mr. Philip Wills as chairman of the Association formed the main business of the official part of the A.G.M., though the chairman's report for 1958, which was not read out, contained a wealth of information about the previous year's activities.

Total flying time for the year was 26,122 hours from 206,787 launches, and, apart from the Air Training Corps, 252 gliders were being operated by 4,015 pilots—1,023 pilots more than in the previous year. Gliding certificate statistics show that, in contrast to the early days of gliding, practically everybody who gets an "A" now goes on to the "B." But not all continue to the "C" soaring stage; for the clubs the figures are 488 "B" and 263 "C," and for the A.T.C. 1,414 "B" and 45 "C."

Loans totalling £18,700 were approved by the Kemsley Flying Trust, including loans to enable two new clubs to start; but several more clubs could have started if they had not been refused the use of suitable airfields. Worse still, three clubs have had to cease operating because their airfields have been taken away from them; the highly successful Kent Gliding Club is particularly hard hit by losing Detling. The main reason for all this trouble, the chairman pointed out, is that "there is no clear Government policy whatsoever in regard to any aspect of sporting flying."

Difficulties with airways were discussed at the informal continuation of the meeting, and Nicholas Goodhart, chairman of the Airways Committee, said that the gliding interests are informed by the Ministry of Transport and Civil Aviation before they establish new airways or regulations, but not before they do their thinking. The Ministry has shifted the airway east of Manchester from over the Derbyshire and Lancashire Club at Camphill, but a new "advisory route" has been sited over the Midland Club at the Long Mynd, and its base cannot be raised above 6,000 ft. because it is used by unpressurized aeroplanes.

The London Club suffers from an airway base at only 3,000 ft., and one difficulty of getting this raised is apparently the flat climbing angle of certain aeroplanes of foreign make which use it. Godfrey Lee, the club chairman, said that his firm would be glad to replace them with better aeroplanes: if only the base could be raised to 5,000 ft., many more sailplane pilots could get away on cross-countries.—A.E.S.

London's First Heliport

SCHEDULED for an official opening towards the end of next month, the Westland Heliport on the south bank of the Thames between Wandsworth and Battersea bridges is now nearing completion. Its overall cost when it is finished will have been in the region of £60,000 and it is expected to be in use for seven years—the period of the lease agreement.

Built as a private venture on the part of the Westland company, the heliport has come into being entirely as an experiment following a detailed investigation made by the Helicopter Association of Great Britain during 1957. Although this investigation showed that a definite need for such a facility existed, it failed to stimulate official support. The area chosen covers 200 sq. ft. and is 3½ miles from Hyde Park Corner.

Although the company do not expect to make a profit from this venture, they intend that the heliport shall operate on a commercially economic basis. Landing and parking fees and the sale of fuel will provide revenue. The landing charges, to begin with, will be 7s. per 1,000 lb. all-up weight.

The shore portion of the heliport which lies in a N.E./S.W. direction is bounded by a 16-ft. river flood wall rising 18 in. above the existing surface level of the site. The take-off and alighting platform is built out over the river and is a rectangle measuring 125 ft. by 53 ft. with the longer dimension parallel with the shore. This is connected to the land portion of the heliport by a 65-ft. wide taxiway; the upper surface of the main platform is 6 ft. above normal high-tide level.

Enclosed on three sides by industrial buildings, the shore-area occupies 40,000 sq. ft., some 75% of which is to be used for the ground movement, fuelling and parking of the helicopters. The park accommodates up to five 8-seater machines.

In the downstream corner of the land area are two buildings connected by a short covered gangway. The largest is a single-storey structure for passengers and staff; while the second—towards the main frontage—is a two-storey building with a store at ground level and an air traffic control centre on the first floor. Two car parks are provided, with room for 20 cars.

For fuel storage there are two underground tanks, one of 5,000 gallons capacity for gas-turbine fuel and the second of 3,000 gallons capacity for petrol.

Fairey Changes

PROPOSALS for a major reorganization of the Fairey Aviation Co., Ltd., and its subsidiaries will be submitted to shareholders at a meeting on March 31. The company thus becomes the latest of the major aircraft concerns to decide on changes to meet new conditions, and follows the current trend in the aircraft industry towards diversification of activities and internal reorganization.

As from April 1 it is proposed that the company's name will be changed to The Fairey Company and that it will act as a holding company controlling group policy and finance. Two new wholly-owned subsidiaries will be formed—Fairey Aviation, which will take over aircraft and allied manufacturing activities in the U.K., and Fairey Engineering, which will be based on the existing Stockport Aviation Co. and will bring together the group's general engineering activities.

The existing Fairey subsidiary companies will not be affected by this change. Instead of being Fairey Aviation Co., Ltd., subsidiaries, they will now have the same status relative to The Fairey Company.

Thirty-five Years' Test-flying

FOR the sixth Barnwell lecture given before the Bristol branch of the Royal Aeronautical Society on March 11 in Bristol, Mr. Cyril Uwins decided to talk of some 50 prototypes which covered the period from the beginning of Bristols until the end of the lecturer's thirty-five years as test pilot. There was no text, the lecturer had provided himself with a few notes regarding performance figures. A most interesting part of the lecture were the observations of Mr. Uwins himself on the incidents which befell him during his work.

Typical of such incidents but not reported at the lecture, but retailed afterwards, arose from an observation about the perils of crossed controls. It appears that the first flight of the Bristol Freighter was made on the same day as that of the Handley Page Hermes which suffered a fatal accident as the result of trimming-tab trouble.

After take-off Mr. Uwins discovered that the trimming tab had been so arranged that it increased, rather than decreased, the load on the elevator. As a result a situation was brought about where increase of speed would have resulted in the loads becoming too large for the pilot to handle and the aeroplane would have dived into the ground. Very nice adjustment was needed to keep the aircraft in trim until it could be brought round on the approach when the pilot was able gently to ease it down.

But this was at the end of a long line of tests and in any case the series, covered by the lecturer, started with the Bristol Boxkites and ended with the Brigand. One distinguished member of the audience remarked that looking at this long string of prototypes induced a feeling that it was an illustration of natural selection, or survival of the fittest. There were more than one new prototype a year on the average yet the actual types which went into production could be numbered on the fingers.

What types these production machines were!—The Bristol Scout, the Bristol Fighter, the Bulldog, the Blenheim, the Beaufort and the Beaufighter.

It was interesting to be reminded again of the curious situation obtaining at the end of the 1918 War when the new aircraft designs coming forward were relying on either the A.B.C. Dragonfly radial or the Sunbeam Arab water-cooled, neither of which engines ever gave a good account of themselves. Indeed, referring to one of his mounts, the lecturer remarked grimly that they did keep the engine running long enough to get them to Martlesham.

It was soon after this War that the Braemar Pullman made its appearance. This was not only remarkable for the fact that it had four engines but also it was a triplane. It had the very rare distinction of having the pilots' seats in the nose fully enclosed.

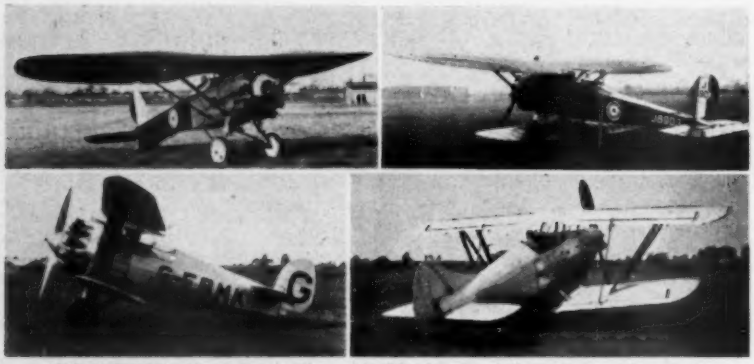
The lecturer stressed the importance of the closest collaboration between designer and test pilot. He had had this to the fullest degree with the late Capt. Barnwell.

One day while flying an interesting biplane with interlinked slots and trailing-edge flaps, the linking struts between the ailerons on the upper and lower wings started to vibrate. Remembering a dictum of Capt. Barnwell's that flutter or vibration could often be stopped by applying a load, Cyril Uwins applied bank and the flutter stopped. He brought the aeroplane back by flying curves first to one hand and then to the other.

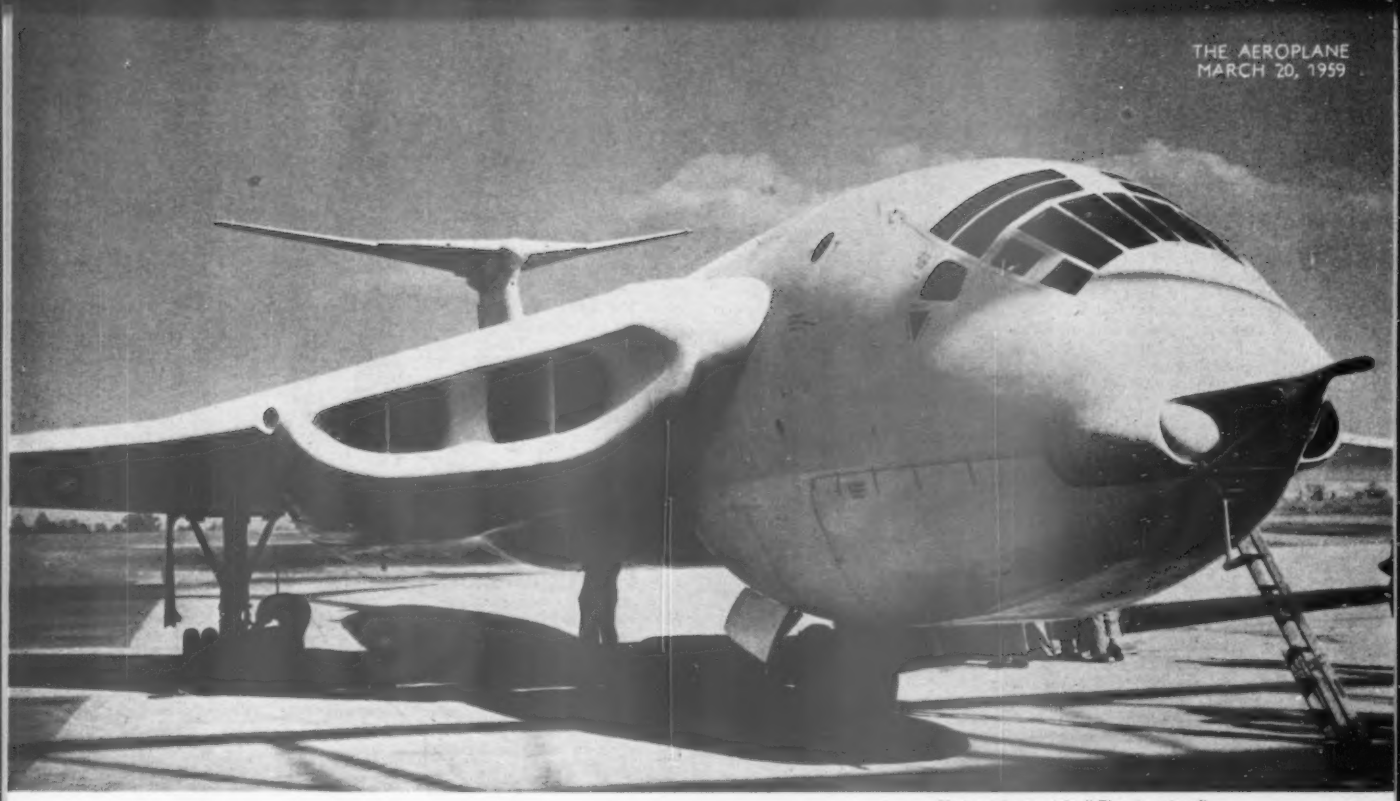
Talking of flutter takes us back to an earlier aeroplane, the Bagshot, when it was discovered that application of aileron resulted in control reversal. The pilot could not see the wing, but Uwins was able to persuade another pilot to come up with him. He confirmed that as aileron was applied the front spar deflected in such a way as to change the wing incidence in the opposite sense.

No preprint was available for this lecture. Fortunately, a tape-recorder was running throughout the showing of the slides. We trust the lecturer will be persuaded to edit the transcript so that it may take its place among the records of the branch.

As Mr. Peter Masefield, president of the branch, said in a tribute to the lecturer, he had lived a vital section of history and an accurate account of his experiences must be preserved.



PROTOTYPES.—Top left, the Bristol Bullfinch as a single-seat monoplane; top right, the Bullfinch as a biplane two-seater in which guise it flew better. The lower wing was attached to the inset rear cockpit. Lower left, the highly tapered wing Badminton. Lower right, showing the Type 123 biplane which had interlinked slots and flaps.



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Victors in Production

IN more ways than one, the Handley Page Victor is a remarkable aeroplane. Both structurally and aerodynamically it embodies some advanced thinking and although its precise performance has yet to be stated, it has been publicly announced that at its operational height it can outfly and outmanœuvre any fighter in service today. By all accounts the Royal Air Force Bomber Command crews are certa nly more than happy with it and we hear of the ease with which it has been able to elude Hunters and Javelins during interception exercises.

The Victor has been designed to operate close to the speed of sound in order to make interception as difficult as possible. This means that the aircraft must be capable of supersonic speed—in a shallow dive. This capability was demonstrated for the first time in June, 1957, and the Victor is still claimed to be the largest aircraft to have accomplished such a speed.

It is interesting to learn that although supersonic operation is not strictly in the Victor's operating handbooks as yet, the R.A.F. crews have been "doing more with the aircraft than they should" in this respect. This was revealed by the Minister of Supply at a Press conference last week; and he added that it was an indication of the fact that the R.A.F. likes the Victor very much.

Even though this, the latest of Britain's V-bombers, has been in operational service barely a year, we were given an opportunity on February 13 to see for ourselves the production and assembly lines at the company's Cricklewood and Radlett factories. One's immediate impression from such a tour is that not only is the Victor most impressive structurally both in detail and in overall conception, but a deal of thought and planning has gone into the problems of production so that it appears to be a comparatively easy aircraft to build. This has, of course, been made no easier by having to involve two factories which are separated by a distance of ten miles or so.

Broadly speaking, a policy has been adopted of using, so far as is possible, split component assembly methods—resulting in a large number of comparatively small units, instead of a small number of large ones. This makes for less complicated jigs and tools, reduces to a minimum the time that any single component remains in the jig, and (very important from the point of view of time and cost)—avoids the need to transport numbers of very big assemblies from Cricklewood to Radlett.

It must not be thought, though, that the Victor airframe is broken down into a very large quantity of very small pieces which are brought together in a sort of final-assembly jigsaw puzzle. Some of the sub-assemblies, although small in comparison with the whole, are nevertheless quite sizeable and heavy units; one could hardly expect otherwise in an airframe that has a span of 110 ft. and a length of 115 ft.

The entire production facilities at both the Handley Page factories are concentrated on Victor work. At Cricklewood one finds principally the manufacture of detail components, such as machined parts, stringers, skin panels and certain sub-assemblies such as the outer and inner wings, elevators, ailerons, nose and trailing-edge flaps, fuselage tail cone and airbrake section, and the fin.

At Radlett, too, some small components are manufactured, such as those that are made on the drop and rubber presses, and also some major sub-assemblies, notably the front fuselage and flight deck. Primarily, however, this is the final assembly area.

No information is available regarding the rate of production of the Victor or the time that is needed to build each aircraft. It has been said, though, that five men skilled in all the processes necessary for Victor construction would spend their entire working lives manufacturing one aircraft. At a conservative estimate this represents 400,000 man-hours per aircraft.

One gets the impression at Radlett that there are surprisingly few complicated jig structures on the final assembly line. This useful degree of assembly simplification would appear to be the result of having a complex sub-assembly breakdown.

During the time of our visit there were about 16 Victors—among which were the first production B.2s—in various stages of assembly, from the initial marshalling of the inner wings and centre fuselage to complete aircraft ready to move to the paint shop and pre-flight hangar.

Apart from the inevitable impressiveness of the final assembly of so large an airframe in quantity, one of the most noticeable features of the Victor that is to be seen at Radlett is the use that is made of every available part of the interior of the airframe for essential equipment. A close look at the interior was not permitted, but one saw enough to realize that the R.A.F.'s latest V-bomber is a most advanced aeroplane so far as its equipment and its airframe services are concerned.

One noticeably outstanding example of the way in which space is used to the utmost was to be found in the bays containing the flying control power-packs. Of necessity, these units are quite massive in themselves and despite the Victor's size there is none too much room for them: those housed in the fin in particular are an extremely close fit between the spars and under the skin panels. It is said, incidentally, that there are 2,200 items of equipment in the Victor supplied on embodiment loan or by outside manufacturers.

Each mainplane is composed of an inner wing housing

the powerplants in its inboard portion and the undercarriage outboard, and an outer wing carrying the ailerons and nose flaps. There is a transport joint between these two major units.

Basically, the mainplane is a multi-spar structure with multiple torsion boxes formed by load-carrying skins. There are three main spar webs and two torsion boxes in the inboard part of the inner wing, while outboard of the undercarriage in the inner wing and also in the outer wing there are four spar webs and three torsion boxes.

For the fuselage, three major sub-assemblies comprise the whole. The front fuselage and flight deck portion extends back to a point approximately in line with the leading edge. The centre and rear fuselage is, in effect, a single component and extends back to the fin leading edge; the bomb bay extends over most of the centre and rear fuselage and is closed by two double-skin doors having a high torsional stiffness. The third fuselage unit is the tail cone which carries the fin and tail unit.

So far as the actual structure of the Victor is concerned, one of the most notable features is the extensive use that has been made of sandwich panels for the wing skin and for other components such as ribs and spar webs. This type of structure, with the skin having bending and shear stiffness in both directions, shows to advantage on the score of structural efficiency and minimum weight coupled with the aerodynamic efficiency to be gained by having a stable skin that does not quilt or wrinkle under load.

The Handley Page team have devoted a good deal of research to this form of airframe construction and they have evolved a manufacturing technique for it that is proving most satisfactory in production. The sandwich form they have adopted has a corrugated core of aluminium-alloy sheet which is attached to the inner skin by means of blind rivets.

For the attachment of the outer skin to the core corrugations, spot-welding is used. This, in itself, is a somewhat radical step—at least so far as it is used on primary airframe structure.

One of the principal problems in developing the use of spot welding to this extent has been to ensure that the quality of the welds is consistently high. An X-ray inspection system is used but clearly if every single spot-weld is so examined the economics of the operation would not be at all satisfactory; indeed early studies by the company indicated that if more than 25% of the welds were inspected by X-ray, then riveting would be a more economical process.

In practice, it has been found that very much less X-ray inspection than this needs to be done and that the weld quality and consistency are remarkably good. A sampling system has been adopted and about 10% of the total number of welds is examined.

The spot-welding shop at Cricklewood is one of the features of the factory and is equipped with a wide range of the latest Sciaky machines. Most of these are of the roll-spot type using wheel instead of point electrodes, although there are examples of the latter which have particular application in some of the smaller assemblies.

Another feature of the Victor's structure which is most apparent when walking round the shops at Cricklewood, is an extensive use of high-quality large machined components. In this direction, of particular interest are the spar milling operations and the machining of the inner-wing main spar webs.

These last-named have large cut-outs to accommodate the air intakes. The front main spar web has a single elliptical aperture in it for this purpose and is a rolled plate machined all over to give the necessary thickness distribution to cope with the various load intensities in different parts of this web. The inner edge of the intake aperture is reinforced with a single-piece forged ring member. The rearmost main spar web has two holes—one for each engine intake and is similarly machined from rolled plate.

For later aircraft—presumably the Mark 2 Victor—these spar webs are to be machined from single-piece forged plates with integral periphery stiffening rings. By this means a useful degree of weight saving is obtained.

One of the most remarkable machined components in the Victor airframe is the longeron which forms an edge member for the bomb bay. This is the longest single unit in the structure—it is of the order of 40 ft. long—and is machined from an extrusion.

Residual stresses in large machined components and subsequent cracking proved something of a problem at one time but this has now been overcome by careful heat treatment during component manufacture. For example, in the case of all large forgings they are machined in the annealed condition. A re-solution treatment is given to all components that are machined from bars or extrusions having a large cross section; this is done either prior to, during, or subsequent to, the machining operation—depending on the nature, size and shape of the part concerned.

Even a cursory glance such as that afforded by a rapid tour of the manufacturing departments and assembly lines at Cricklewood and Radlett makes it clear that the Victor is full of interest as a structure and as a production operation. As Sir Frederick Handley Page said last week, this aircraft represents a vast range of technical achievements. And the Victor B2 with its larger wing, more powerful engines, and greater carrying capacity, promises to be an excellent successor to it.

During the course of our visit, the prototype Victor 2 was flown for the benefit of the photographers. Watching it circle the aerodrome at low altitude one was left with the impression that the increase in span had improved the lines of the crescent wing. So far as the take-off was concerned, all one can say is that it was—for such a large aeroplane—incredibly short. The four Conways, leaving a noticeable smoke trail, were as noisy as one would expect the development of nearly 70,000 lb. of thrust to be. But during a subsequent fly-over at a slow cruising speed there was a good hint of the quietness that may be expected from bypass powerplants.—F.T.M.

ASSEMBLY AT RADLETT.—There are two main final assembly lines of Victors in the large hangar at Radlett. This recent photograph shows part of the extensive assembly area.

General Aviation News

NAPIER AMALGAMATION.—Napier's aero gas turbine division, together with its research station at Liverpool and its piston-engine division and research department at Acton have been amalgamated to form one technical division under Mr. A. J. Penn as technical director.

TRAINER TRIALS.—The R.A.A.F. is to operate a Hunting Jet Provost on six months' trial at No. 1 Basic Flying School, Point Cook. Two R.A.A.F. trainee pilots are to start their flying training on the Jet Provost in May, when the rest of their course will receive instruction on the Winjeel—the standard R.A.A.F. basic trainer.

VANGUARD HOURS.—In the first 50 days since flights began, the Vickers Vanguard has averaged one hour a day in the air, having completed 50 hours by March 11. So far, it has flown at altitudes up to 26,000 ft. (fully pressurized), speeds up to 250 knots and weights up to 131,000 lb.

ACTIVE ANTONOV.—Latest design from the versatile Oleg. K. Antonov is the all-metal A-13 sailplane, which is intended to improve the relatively low standards of Soviet soaring. It weighs about 700 lb., and has a gliding angle of around 1 in 26.

STARFIGHTER RECORDS.—A U.S.A.F. Lockheed F.104 Starfighter has set up seven time-to-height records for climb to 3,000, 6,000, 9,000, 12,000, 15,000, 20,000 and 25,000 metres. This is the first time records have been set up for climb to 20,000 and 25,000 metres; the times taken were 3 min. 42.99 sec. to 20,000 m. (65,616 ft.) and 4 min. 26.03 sec. to 25,000 m. (82,020 ft.) The Starfighter also holds the world speed record of 1,404 m.p.h. and the altitude record of 91,243 ft.

ARMED FOR CEYLON.—The first Hunting Jet Provost T.3 for the Royal Ceylon Air Force has been undergoing armament trials at Boscombe Down. Ceylon is the first overseas customer for this type.

X-15 TESTS STARTED.—The North American X-15 manned research aircraft was taken aloft for the first time on March 10 in a "captive" test under the wing of its B-52 mother aircraft. On this initial flight the X-15 was carried un-fuelled but with the pilot, Scott Crossfield, in the cockpit. Glide tests followed by powered flights are planned to start in a matter of weeks.

GREENLAND EARLY WARNING.—The North American Distant Early Warning Radar Line (DEW) that runs from the Aleutian Islands, around Alaska and across Canada to Eastern Boffin Island is to be extended across Greenland. Four stations are to be built in Greenland at a cost of more than $27 million.

LEIPZIG ORDER.—A contract for aero-engine turbine blades worth approximately £100,000 has been received by Napiers from the East German Government.

G.91 PROGRESS.—Confirmation has now been received of the order for 50 Fiat G.91s for ground attack duties with the West German Luftwaffe. In addition to these aircraft delivered from Italy, a further quantity of G.91s is to be built in Germany by the Flugzeug-Union Sud, under licence. A later development of this lightweight tactical strike fighter, the G.91V, will be powered by a Bristol Orpheus B.Or.12 afterburning turbojet, and will be supersonic in level flight.

MARCEL DASSAULT HONOURED.—The Gold Medal of the Royal Aeronautical Society has been awarded to M. Marcel Dassault, the well-known French aircraft designer, for his "outstanding contributions to the design and development of aircraft."

SABRELINER ENGINES.—The 3,000-lb. thrust Pratt & Whitney JT-12 turbojet has been selected to power the North American T-39 Sabreliner twin-jet utility trainer to be produced for the U.S.A.F. Production versions of the T-39 will have provision for external wing tanks. The first production aircraft is due to be rolled out early in 1960.

SECOND CARAVELLE.—First flight of the second production Sud Aviation Caravelle, destined for Air France, was made from Toulouse on March 4.

SATELLITE RECOVERY.—The next Discoverer satellite may be used for a controlled re-entry experiment. An instrument capsule fired backwards will return to Earth on a parachute and be recovered with a net supported between C-119 transports.

F-27A DELIVERED.—Fairchild has delivered the first F-27A, with Dart 528 (R.Da.7) turboprops, to Pacific Air Lines. The six Pacific F-27As are 44-seaters and will enter service on May 1.

U.K. CONTROL.—The first of two radar control centres designed to handle U.S.A.F. air traffic in the U.K. is now in full operation at Wattisham. The second centre at Upper Heyford is expected to be in operation later this year.

VERTIPLANE LOSS.—The Ryan VZ-3 Vertijet deflected slipstream VTOL prototype crashed at Moffett Field, California, in mid-February. The pilot was not seriously injured, but the aircraft is understood to be a complete write-off.

MORE NEWS ITEMS APPEAR ON PAGE 356.

LIGHTNING FUELLER.—This aircraft refueller, seen at the stern of an English Electric Lightning, is one built for the Ministry of Supply by Zwicky Ltd. of Slough. The refueller shown here was wrongly described in our issue of February 13 as the result of incorrect information being given us.

Air Transport

Silver City and Manston

WHEN, late last year, Silver City explained the new fare reductions it was hinted (see THE AEROPLANE for December 19, 1958, p. 886) that Manston aerodrome might need to become a second base for the vehicle-ferry services as Lydd became more hard-pressed. Last week Silver City announced that Manston would come into civil use on June 15, when a new rail-air London-Paris service would be started.

In association with British and French Railways this "Silver Arrow" service, with a return fare of £8 19s., will involve a train journey between Victoria Station and Margate or Birchington and between Le Touquet and Paris, with an air journey between Manston and Le Touquet. Initially coaches will be used to convey passengers between the railway terminals and the aerodromes, but it is hoped that, eventually, spur lines may be laid down into both Manston and Le Touquet. The overall journey time will be about seven hours.

The services will start on a daily frequency using 68-seater Handley Page Hermes, of which British Aviation Services have five. Passengers will travel to and from Victoria in reserved coaches and to and from Paris in chartered diesel rail-cars.

The plan, which obviously involves very close co-operation with the railways, shows an important trend of thinking on the part of the British Transport Commission, which is clearly and sensibly prepared to make the best of a changing passenger-travel situation.

Manston, which, until about a year ago, was a U.S.A.F. fighter base, is now back in the control of the Air Ministry and Silver City is taking over its use on a lease basis. R.A.F. personnel will continue to man ATC and certain other operational services.

All Silver City licences are now operative for either Manston or Lydd. With vehicle bookings this year already amounting to more than 33,000 it seems possible that Manston may be needed as an overflow departure and arrival base even before ferry operations at this aerodrome are, in due course, planned into the overall pattern of services. The booking figure at March 10 shows, incidentally, a 40% increase on that for the same date last year.

Irish Air Lines' Decision

THREE Boeing 720s have been ordered by Aerlinte Eireann, the Irish national air line operating over the North Atlantic. This decision was foreshadowed in THE AEROPLANE for January 30 (pp. 122-123) when some of the factors influencing the choice were discussed. Aerlinte has been interested in Atlantic operations since 1947, but was able to make a start only in April, 1958, by means of an agreement with Seaboard and Western Airlines, which provides the Super Constellations, and crews, used at present.

A careful study of the Atlantic route has been made by Irish Air Lines and the conclusion reached that a "reasonable surplus over outgoings and a return on capital" can be made, assuming a continuing expansion of traffic and maintenance of fares at their present level. The purchase of jet equipment is being supported by the Irish Government, although the precise method of financing the £4,200,000 order is still under consideration.

Delivery of the three aircraft is expected in late 1960 or early 1961, and services will begin in the early summer of 1961 between Shannon, New York and Boston. The operation will be a wholly Irish one, using flight crews who will be selected from the present Aer Lingus personnel flying Viscounts and Friendships.

The order is the first for the oversea version of the Boeing 720, already ordered for domestic routes by American Airlines and United Airlines. Boeing state that this version will carry its full passenger payload over a 3,550-mile range; maximum tourist accommodation is 153. Boeing 720s ordered so far are to be powered by the lightweight 12,000-lb.s.t. Pratt & Whitney JT-3C-7: engines for the Irish Air Lines' aircraft have not been specified.

B.O.A.C. Executive Changes

TWO important changes in the senior management of B.O.A.C. have been announced. They are the appointment of Captain T. H. Farnsworth as chief of flight operations in succession to Captain J. N. M. Weir; and of Dr. K. G. Bergin as director of personnel and medical services, consequent upon the resignation of Mr. H. Spear as chief personnel officer.

Captain Farnsworth has been with B.O.A.C. since its inception, having first joined Imperial Airways in 1936 from the R.A.F. After flying Short boats on the Empire routes for seven years, he went on to the Atlantic service with the Boeing 314s in May, 1943. From the end of the war onwards he has been closely concerned with the development of new aircraft for the Corporation—notably the Comet and the Britannia.

The award of the Queen's Commendation for Valuable Service in the Air in 1954 was largely the result of his work on the Comet. His previous appointment with B.O.A.C. was as deputy chief of flight operations.

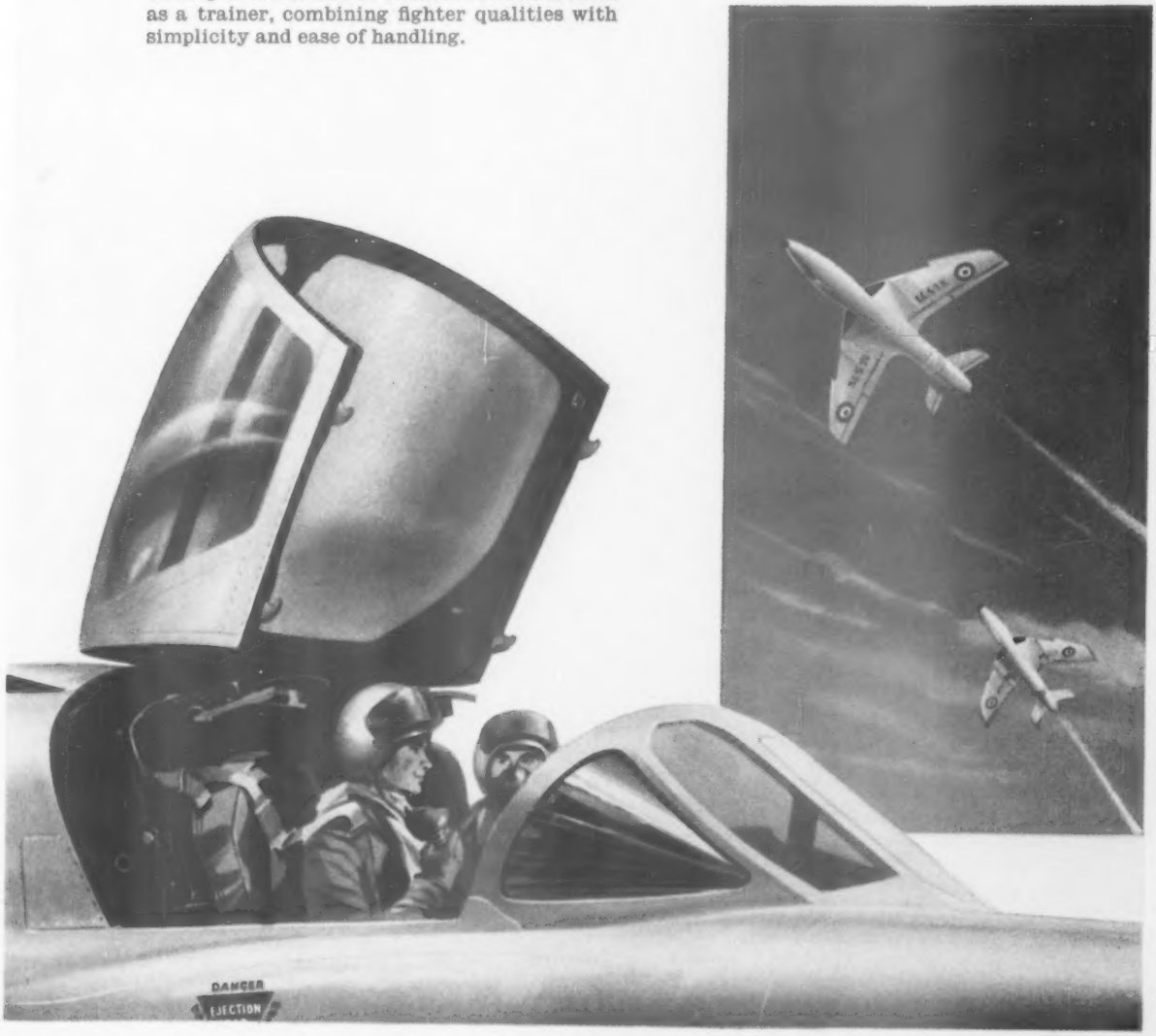
Captain Weir has relinquished his appointment at his own request following a recent illness, and has been appointed regional representative, South-West Pacific, based in Sydney, Australia.

Dr. K. G. Bergin will now be directly responsible to the managing director for "the whole field of human relations within the Corporation," by the amalgamation of the personnel and medical branches into a single department. Dr. Bergin joined B.O.A.C. in 1946 from the R.A.F., and has been chief medical officer since 1956. He has been actively engaged in the medical care of flying staff, and in allied problems, for the past 18 years.

CIVIL AND MILITARY.—Keeping company with two Boeing 707-120s for American Airlines and another for T.W.A. on the ramp at Renton is the first of three VC-137A staff transports for the M.A.T.S. Versions of the civil 707-120 for use on special air missions, the VC-137As have high-visibility, bright orange fluorescent markings on tail, nose and wing tips.

THE HAWKER HUNTER TWO-SEATER . . . PERFECT TRAINER FOR SUPERSONIC FLIGHT

In service with no fewer than a dozen air forces, the Hawker Hunter has proved its worth in a variety of roles. The two-seater version is ideal as a trainer, combining fighter qualities with simplicity and ease of handling.



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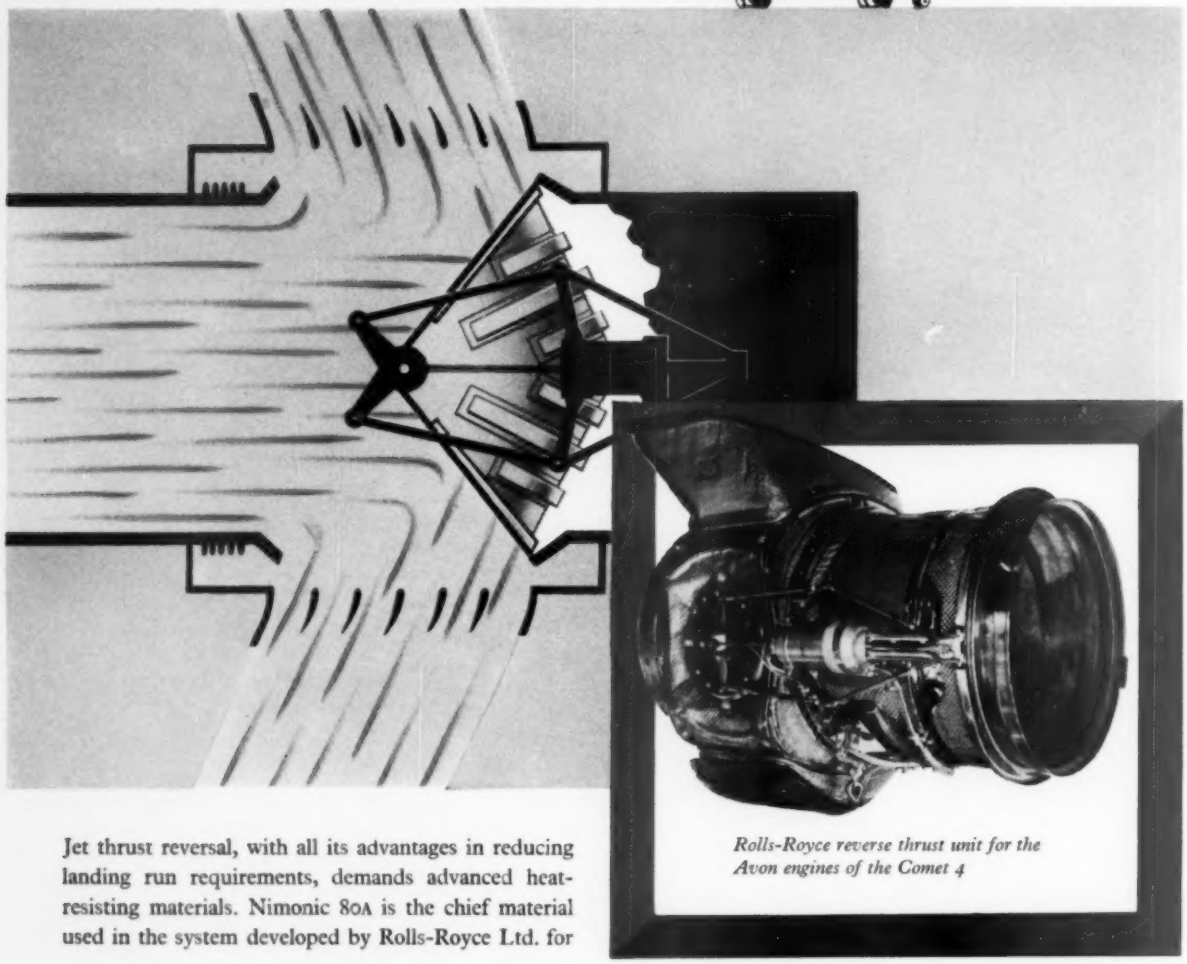
To take the strain of reverse thrust...



Jet thrust reversal, with all its advantages in reducing landing run requirements, demands advanced heat-resisting materials. Nimonic 80A is the chief material used in the system developed by Rolls-Royce Ltd. for the Avon engines of the Comet 4 and the Conway engines of the Boeing 707-420.

Nimonic 80A withstands the high temperatures and stresses involved in deflecting hot gases moving at very high speed. In Rolls-Royce thrust reversers, it is used for the inner lining of the jet pipe and for the clam-shell doors which take the brunt of the shock when reverse thrust is selected.

Rolls-Royce reverse thrust unit for the Avon engines of the Comet 4

...Rolls-Royce use NIMONIC* Alloys

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TCA 118

South American Commentary

FEDERICO B. KIRBUS *discusses—not too seriously —the turbojet market, airport deficiencies and future plans, the tariff war and other matters.*

ONE OF THE outstanding aspects of the turbojet market south of the Río Grande is that Boeing, who have neatly handed Douglas a wet fish by delivering the 707 almost a full year before the DC-8 (if everything goes well with Donald Douglas' latest bigger and better bouncing baby), have conspicuously failed to achieve anything like sales success in South America. It hasn't been for lack of trying; Boeing salesmen have done everything except organize revolutions in order to get their aircraft sold. But the answer has been a soft-spoken nix in Spanish and Portuguese. Only Varig (Brazil) and Cubana (guess where) have imprinted their marks on contracts for 707 variants. On the other hand, Douglas have not had very much more success, either, with only four DC-8s ordered by Panair do Brasil.

The big orders are going to the medium jets, like the de Havilland Comet and the Sud-Aviation Caravelle. Which points out the reason why the big American suppliers have laid eggs all over the continent; their king-size jets are too big for any market except a super-rich one. And economy-size stage lengths don't suit South American conditions, either. It's a big continent, but, for an air service to pay, it has to do a fair job of tying in as many cities as it can on its way—and that means more like a sort of glorified grasshopping than 707/DC-8-type stage-lengths.

Besides, hardly any airfields in South America are long enough to accommodate these big jets; in fact, some republics in Central America are hardly long enough, if it comes to that. Of course these countries will have to subtract pesos from the current revolutionary budgets in order to provide themselves with jet-age airfields, but the process isn't going to reach a happy conclusion tomorrow, or the day after.

The jet age seems to have arrived in South America, but its first symptoms are significant. Aerolineas Argentinas have already received their first Comet 4, their second and third are on the way; with these three aircraft in hand they plan to start operating in May with, in due course, four services weekly to New York, five weekly to Santiago de Chile, and two weekly to London. A day later a goaded Pan American Airways also said defiantly that they, too, were starting jet services to South America, so there. However, Pan Am's operations are of a rather curious nature, as their announced schedule (starting in April with 707s) is New York-Carácas-Asunción, Paraguay.

There seems to be about as much reason for a direct N.Y.-Asunción service as there is for a scheduled daily flight between Aix-les-Bains and Memphis, Tennessee. Of course, you could deplane at Asunción and hop a local carrier the rest of the way to the more important centres of Rio de Janeiro, Buenos Aires, Montevideo and Santiago de Chile. But you will soon be able to get to Rio and B.A. without changing aircraft by Aerolineas' Comets.

The implication is this: that Pan Am's inaugural whoosh-flights down South, heralded by a loud and insistent tin-can-and-wooden-stick publicity campaign, are intended more than anything else to show those innocent South Americans that they, too, have jet airliners, designed and built in America by Americans. Whether they will be able to fill their 160 seat Queen Elizabeths of the air is extremely doubtful. Significantly, Pan Am announced this eccentric-sounding route as being due to two main reasons: (1) bilateral agreements preventing them, for the time being, from extending southwards to the logical flight terminus, Buenos Aires; and (2) nothing doing on the East Coast due to inadequacy of the Brazilian airfields—which are, however, large enough to fit in the Comets. What with potential traffic and airfield limitations, the Comet is as good as custom-tailored to the South American market—and words to that effect were spoken when Aerolineas' first Mark 4, LV-PLM, was handed over in February.

Meanwhile the tariff war continues unabated, in spite of conference after conference in various South American capitals. The recent IATA *v.* non-IATA skirmish in Rio de Janeiro notoriously failed to produce Something of Value, and Argentina's Transcontinental, one of the new but go-ahead independent carriers, recently cabled IATA's South American representative, Ruben Berta of Varig, refusing to climb on the International organization's sadly battered bandwagon. Shortly afterwards something significant happened: Berta, appointed by IATA to woo the independents to their ranks, resigned without explanation. Meanwhile ALTA, an organization of the IATA type set up by South American airlines among themselves just to make the overall picture even foggier, announced another mid-March meeting in Lima to try to work out an agreement to ensure that dog fails to eat dog.

On a bilateral scale, U.S.A. and Brazil have recently inked an agreement allowing Brazilian airliners to operate Rio-Tokyo with stopovers in L.A. and Honolulu, while the Americans are to be allowed to and from Brazil's not-yet-inaugurated Federal Capital, Brasilia, and, finally, American lines are to fly from the U.S.A. through Brazil and the Antarctic to Sydney, Australia —always provided okays are granted by the countries (about 266 at the last count) which claim sovereignty over the Antarctic.

Airfields are in the news, too. The people with the biggest hat in their hands are the Chileans, who have asked the U.S. Government's Loan and Development Fund for some 10 million dollars with which to evaluate, design and build a jet-age field in a spot which boasts the unlikely name of Pudahuel. Present Los Cerrillos is hampered badly by inadequate strip lengths and by the Andes, which get in the way. Of course, Chile is a long, narrow strip, but at Pudahuel, it seems, the 20,000-ft. mountain chain relents sufficiently to permit safe jet operation. Washington's Ambassador to Santiago, Walter Howe, recently flew to DeeCee to chat about this to Fund officials.

Another Chilean project is an airfield of jet-age size for Easter Island, lately more famous for Thor Heyerdahl and his mysterious stone figures, but also a natural stopover for a South America-Australia air service. It is expected that preliminary surveys will start soon on the best way to land on Easter without smacking into an eight-foot-high stone statue, an activity which, we understand, annoys the natives. And the passengers.

Airport rumblings also come from Brazil, where air authorities, veteran pilots and airlines stopped celebrating Carnival long enough to hurl frightful accusations at each other as a result of two or three recent crashes or near-crashes at Galeao, Rio's International airport—which is no abandoned airstrip by any means, but which lacks the last word in approach equipment. The Brazilian Government have recently handed out a credit for the purchase of GCA and ILS, and it is hoped to avoid accidents such as that to Lufthansa's Super G Constellation. One does hear, however, that the Government suddenly decided new equipment was required when President Juscelino Kubitchek's own Vickers Viscount made a forced landing at Galeao through equipment inadequacy.

B.A. ARRIVAL.—One part of the scene at Ezeiza Airport, Buenos Aires, after the arrival of the first Comet 4, LV-PLM, for Aerolineas Argentinas. In the group can be seen Air Cdre. J. J. Guiraldes, A.A.'s president (next to top row, left), Gp. Capt. A. MacDougall, D.H. representative in South and Central America (front row, left centre), and (behind him and to the right) Gp. Capt. J. Cunningham, de Havilland's chief test pilot.

Thoughts after Montreal

SEVERAL complete issues of THE AEROPLANE would be necessary to provide an objective and fully documented account of the three-week struggle during the short-range navigation aids meeting at Montreal last month. But, now that the meeting is over, it does seem to be necessary to attempt to clarify and to expand some of the points which were made and which have inevitably been over-simplified in the reports and comments provided so far.

At the first plenary session, on February 10, the representatives of the two main protagonists, the U.K. and the U.S.A., showed very clearly in their statements the fundamental differences in their philosophies, official or otherwise. Whereas the U.S. representative spoke of the need to start with a simple and already accepted basic system and to add to this as operational requirements developed, the U.K. representative was primarily concerned with the need for planning much more bravely and broadly to meet the requirements of the future.

The U.S.A. wanted to develop a single existing aid; the U.K. wanted this to be supported by another, more prospectively effective aid, which could eventually supersede the first and become an additional World standard in time to meet the traffic control and programming requirements of the future. The U.K. representative did not press for the universal employment of Decca, now or in the future, but only for its use in areas where the overall operational requirement could not be met by VOR/DMET—adding that it would be less expensive, safer and more efficient to plan a change in the overall navigation system earlier rather than later.

The meeting may well, as the U.K. delegation complained, have gone off the rails so far as objective technical evaluations of the two systems were concerned, but this certainly was not for want of trying by those who planned the meeting; the agenda was primarily concerned with the operational requirements which had to be met and with the required capabilities of the proposed aids. The proposed systems were to be judged under 29 headings which appear to have covered nearly all possible points; the material developed under these headings was such as to fill, in due course, the greater part of a 100-page appendix to the draft report of the meeting. Presumably the delegates had, in fact, had ample opportunity to become familiar with this material, but it was significant that the delegates voted against a proposal that a working group should be appointed to make a detailed comparison of the two navigation systems.

The fact that no such point-by-point comparison of the capabilities of the systems had been made by the meeting was strongly criticized by the U.K. delegation and this criticism was equally strongly rebutted by the chief of the U.S. delegation in his final statement. He said, amongst other things, that the representatives had had ample time before the meeting; that a working group had considered the U.K. and U.S. views on operational requirements; and that the differences on certain points had been considered in open debate and decisions taken.

In this final statement, the U.S. delegate summarized his technical objections to Decca. In particular he stated that its proponents had not been able to show that it met all the four essential requirements: technical reliability; simplicity in use; maximum accuracy consistent with reliability and simplicity and with the job to be done; and navigation service at altitudes and distances which are operationally significant. Decca, in operationally usable form, could, he said, become available only to a restricted class of large aircraft and the chart distortions demanded mental reorientations from the pilot. He concluded his statement with an outline of the development and growth potentialities of VOR/DMET.

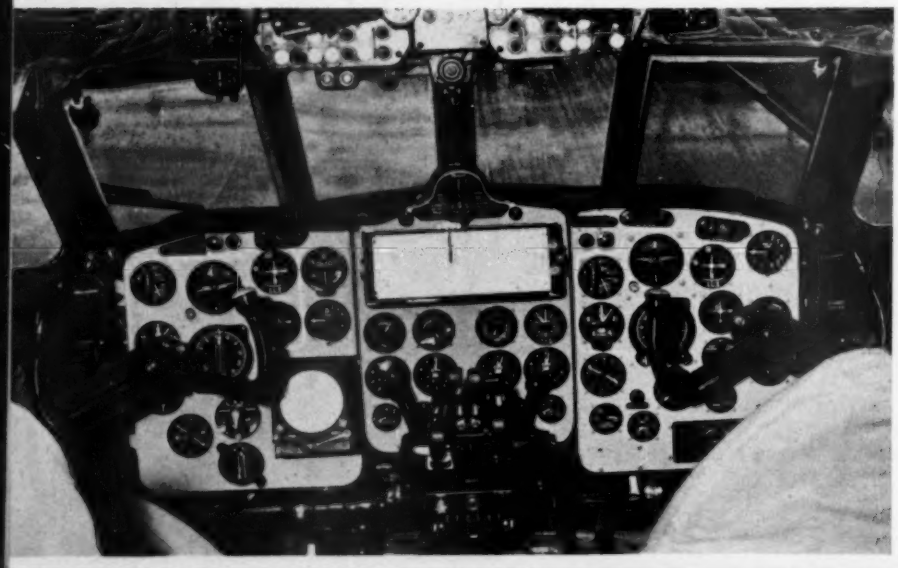
The U.K. delegate roundly stated that the meeting had failed to do its primary task of developing operational and quantitative requirements and that there was, therefore, no basis for specifying a short-range navigation system. The meeting had refused to examine critically and objectively the aids offered, and the U.K. delegation had "been forced to conclude that opposition . . . was influenced by the fear that VOR/DMET would be found wanting when compared with Decca." The decision to retain VOR and to adopt DMET as a complement "was due in large measure to fixed positions adopted before the meeting and to an unwillingness to appreciate the full implications of the problems. . . ."

Among the reasons given for the U.K. opposition to the adoption of DMET were that no objective assessment had been made of its capacity to satisfy requirements; that operational and technical evaluation of DMET had been made by an insufficient number of states to justify its adoption; and that its implementation would be difficult, or even impossible, in some areas because the system had to be comparable with the military Tacan and must share frequency channels with Tacan and with secondary surveillance radar.

There was, in fact, no objection by the U.K. to the continued use of VOR—though protection of the system until 1975 was considered unrealistic—but only to the adoption of DMET, the military sponsored complementary ultra-high-frequency distance-measuring equipment.

The main difficulty for an outsider, whether present in person or not at a meeting of this kind, is that of judging the relative influences on delegates of their personal convictions and of the Government or Ministry briefs to which they are being forced to work. When reading the various statements in objective quiet, and even when listening to them being read in active session, one might come to the conclusion that there was an absolute conviction of rightness on both sides. But it is to be suspected that the delegates were following briefs based on unalterable policies and that, for instance, the U.S. representatives at the meeting were as well aware of the obvious advantages of a hyperbolic area-coverage system as the U.K. representatives were aware of the points in favour of the principle of developing an existing aid which is in widespread use.

ICAO, which is, in effect, a specialist technical extension of the United Nations, holds its meetings open to anyone who has reasonable justification for being present. Faces must, therefore, be saved and policies maintained. Now that the minor public hubbub has died down, the principal representatives at the meeting should enjoy a quiet chat in anonymous surroundings while they try to think of some compromise variants of the recommendations which will be acceptable to ICAO member states, to the organization's Air Navigation Commission and to the Council. The important thing, after this storm in an aeronautically important teacup, is to maintain tranquility of spirit and not to be forced into some untenable corner from which we, in the U.K., could do no more than bare our teeth in an inevitably ineffectual gesture of defiance.



PICTORIAL PRESENTATION. — In the Ministry of Supply Comet 2E used for Decca/Dectra demonstrations before the ICAO COM/OPS/RAC meeting in Montreal, the Flight Log is mounted at the top of the central power panel, with the Decometers and Dectra range meter below it.

The facts and figures give me confidence in the VISCOUNT

Continental Airlines' results exceeded expectations

These are the figures after six months' operation

Average fleet for period: 5.6 aircraft

Total revenue	$ 2,599,962
Direct expenses	$ 1,126,817
Indirect expenses	$ 954,188
Net operating income	$ 518,957
Income per mile	31.16 cents
Average load factor	47.17%
Break-even load factor	37.3% (twenty passengers)
Percentage indirect/ direct costs	84.68
Revenue passenger miles	40,845,739
Yield per revenue passenger-mile	6.08 cents

In May last year, Continental became the first airline to operate the Viscount 810 on the American continent. According to President Robert F. Six, performance, passenger appeal and economics of the new aircraft exceeded the expectations of the company. In the first three months 1,200,000 plane miles were logged, and seat mile costs were .30 cents below estimate. Although bigger and faster than earlier Viscounts, air mile costs of the 810 are no higher.

Latest improvements in performance enable Viscount 810 to offer even greater performance for operators

- ★ Take-off weight now 72,500 lb (up 3,500 lb)
- ★ Landing weight, zero fuel weight and payload all increased by 2,000 lb
- ★ Maximum payload range increased to 1200 miles
- ★ Cruising speed 365 m.p.h. When re-engined with more powerful Darts, 400 m.p.h.
- ★ Backed by Vickers/Rolls-Royce jet-prop experience of over 350 Viscounts in service with 39 airlines
- ★ Viscount 810/840 already ordered by Continental Airlines, Lufthansa, South African Airways, Ansett-A.N.A., Airwork, Cubana, Hunting-Clan, Pakistan International Airlines, T.A.A. and V.A.S.P.

VICKERS VISCOUNT 810/840

FOUR ROLLS-ROYCE DART JET-PROP ENGINES

• *Fastest and most economical medium-sized airliner in the world*

VICKERS-ARMSTRONGS (AIRCRAFT) LIMITED WEYBRIDGE SURREY ENGLAND

TGA AT611/A

. . . and talking of purity, I pointed out to him
that all fuel delivered to aircraft by AIR BP
is first put through a separator which removes
99.99% of any water present.

Quite right! Never mix water with spirits.

AIR BP

THE AVIATION SERVICE OF BRITISH PETROLEUM

SCOOP!

It's powerful, and silent. It's the new reversible Desoutter screwdriver—the very first tool to use the Super Atom air motor. Fifty per cent more powerful than even the Mighty Atom motor, without any increase in diameter. Like the new Mighty Atom drills, it's fitted with the popular oil-resisting grip and adjustable silencer/exhaust. More power, less noise, and great to handle! There's not another screwdriver like it.

The new Super Atom reversible screwdriver is supplied with lever control handle and suspension bail, as standard. A complete range of interchangeable bits are available. Clutch components and all accessories are interchangeable with existing models.

Patents applied for.

Type	Speed	Capacity		Weight		
		Wood Screws	Metal Screws			
	rpm		ins mm	lbs	ozs	kg
2 SA8/2000	2000	No. 6	5/32 5	1	12	0·8
2 SA8/1500	1500	No. 8	5/32 5	1	12	0·8
2 SA8/1000	1000	No. 8	5/32 5	1	14	0·85
2 SA8/500	500	No. 12	1/4 6	2		0·9
2 SA8/300	300	No. 14	5/32 8	2		0·9

Desoutter

SUPER ATOM REVERSIBLE SCREWDRIVER

Manufactured by Desoutter Brothers Limited, The Hyde, Hendon, London NW9.

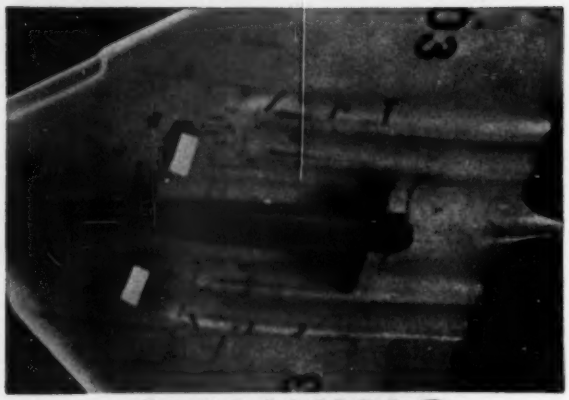
CXC 313

THE

VULCAN

GETS

NEW



STRIKING

POWER

AVRO STAND-OFF BOMB GIVES V-BOMBERS EXTRA FLEXIBILITY IN ATTACK

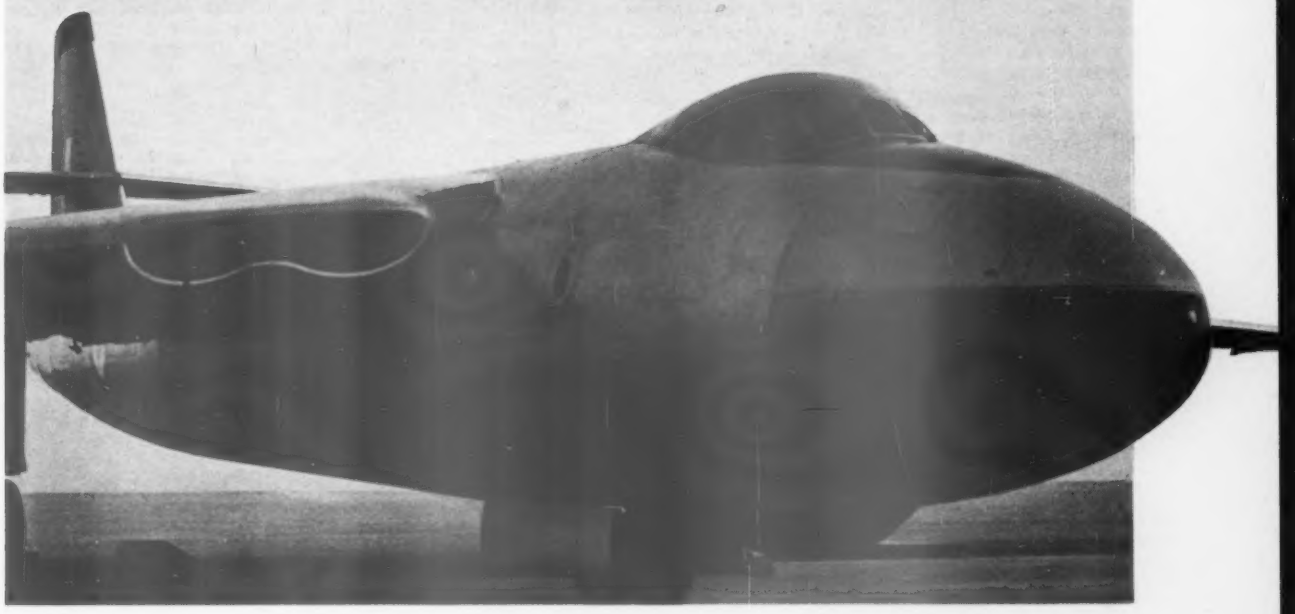
Britain's most advanced V-bomber, the new Avro Vulcan B. Mk. 2, due to enter service with RAF Bomber Command this year, will be equipped to carry one of the most powerful weapons ever invented for the preservation of peace. This is the Avro Stand-off bomb, first air-to-ground guided missile to be developed in this country, which is designed to destroy an enemy target without the aircraft having to penetrate the ring of defences. Designed and built by the Weapons Research Division of A. V. Roe, the Stand-off bomb gives new power to the Avro Vulcan which becomes an even more formidable bulwark against aggression.

AVRO VULCAN

POWERED BY BRISTOL OLYMPUS ENGINES

A. V. ROE & CO. LIMITED, MANCHESTER / ***MEMBER OF HAWKER SIDDELEY AVIATION DIVISION***

MILITARY AIRCRAFT



Photograph copyright "The Aeroplane"

ALTHOUGH, generally speaking, the remarkable growth in the peaceful application of aviation during the past few years has tended to overshadow the military side of the picture, throughout the World the more spectacular advances in the science of aeronautics recently have been brought about by the stringent and specialist requirements of the Service operators. Developments in this direction have been dictated as much by the overall progress made in airframe and aero-engine technology as by the introduction of the newer weapons such as guided missiles and stand-off bombs which inevitably demand more sophisticated carriers. And while there is a general trend towards automaticity and the use of unmanned weapons, there is still a widespread requirement for conventionally piloted aircraft for defensive as well as for deterrent offensive duties.

In the 19 pages of the Military Aircraft supplement which follows, we survey some of the current problems and developments. A special pull-out spread of drawings illustrates, to a common scale, 28 of the World's level-flight supersonic aircraft. And a table of data at the back of the pull-out gives detailed information on contemporary leading military aircraft, including certain research projects from a dozen or more different countries.

The first of the four articles in the survey deals with present and future requirements for aircraft and missiles for the Royal Air Force and shows how its operational capability is being maintained and improved. The second article gives an outline of the equipment and special duties of the Fleet Air Arm. There is also a detailed summary of the very important subject of aircrew environmental requirements with a discussion of some of the more recent contributions made by industry working in conjunction with the aero-medical specialists to enable aircrew to work efficiently and to survive in emergency. Finally, we have summarized a recent lecture in which an Army officer set out the various rôles which helicopters in the appropriate classes could be expected to perform in the modern Army and particularly in nuclear warfare conditions.

Military Aircraft . . . .

Improving the Capability

ONE of the most difficult problems that has continually faced any air power, and is growing more acute each year as the pace of technical development increases, is the struggle to maintain and improve its all-round operational capability against the developments and progress achieved by the other air forces of the World. To overcome this the short- and long-termed equipment requirements of the Service must be accurately forecast; also the operational units must continually alter and modify their operating techniques to obtain the highest possible effective use from this equipment.

An extremely instructive example of the surveying of the general requirements of an air force, although it was not a typical forecast in the true sense, was given on behalf of the R.A.F. last May when the Service staged its exercise "Prospect II." In this exercise, which it will be recalled took the form of a conference to which some 300 guests were invited, the Assistant Chief of the Air Staff (Operational Requirements), Air Vice-Marshal W. H. Kyle, C.B., C.B.E., D.S.O., D.F.C., gave an instructive survey of immediate and more distant future equipment requirements of the Service for its many operational rôles.

A study of his survey in the light of more recent developments since that date brings out the interesting fact that almost all of the aircraft or equipment asked for, or outlined as a requirement, are now being developed for the Service. It is mainly upon this study that the following article dealing with the operational capability of the R.A.F. is based.

Starting with our main form of deterrent against a future war, the Bomber Command strategic bomber force, it is interesting to note that the recent Ministry of Defence progress report on the first two years of the Government's five-year defence plan stated that the Avro Vulcan B.1 and the H.P. Victor B.1 "in performance, in speed and altitude, remain unsurpassed by any bomber aircraft in service in any other country." Coupled with other authoritative statements this rather misleading sentence, which conveniently does not mention the subject of range, does at least confirm that the two mentioned V-bombers have a better overall operating performance than their U.S.A.F. counterparts (B-47s and B-52s) if based in this country.

The American aircraft have a greater range, but until the B-58 Hustler and the later B-70 Valkyrie come into service, the Vulcan and Victor together with their later Mk. 2 developments, are generally considered to have a superior performance when it comes to penetrating enemy defences. Both the Hustler and the Valkyrie are, of course, in a different category and will exceed the performance of our V-bombers.

Defences against air attack are continually being built up to reduce the effectiveness of the bomber and to counter these its performance and operational effectiveness must be improved. For this a number of openings are possible and the R.A.F. is attacking the problem by the introduction of later marks of aircraft, the development of stand-off bombs (ASMs), flight refuelling and the greater use of electronic counter-measures.

Both the later marks of Vulcan and Victor have flown and the two bombers are in production for the Service. The Vulcan B.2 is powered by four 200-Series Olympus engines of about 17,000 lb. s.t. each, compared with the earlier B.1 aircraft which have the 13,000-lb. Olympus, it has a much greater wing span than the B.1, an increased gross weight and its wing is of a reduced thickness-chord ratio. The wings also incorporate conical camber on the cranked leading edges.

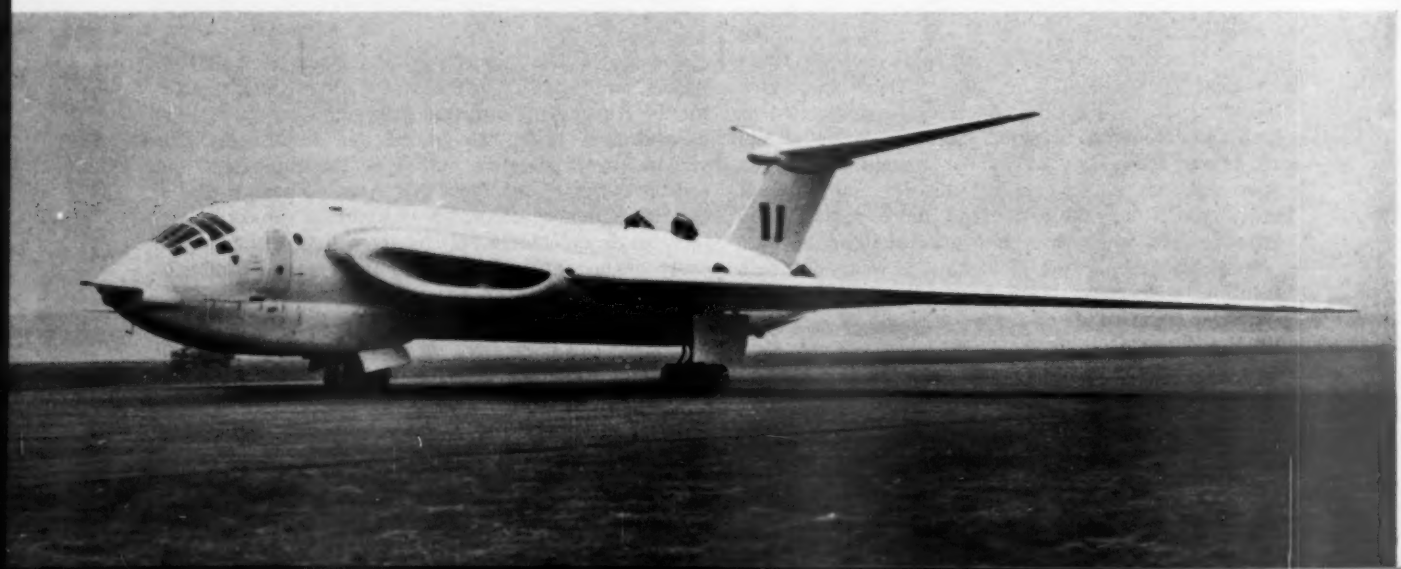
Similar to the Victor B.1 in external appearance, the Victor B.2 also has a greater span and wing area combined with more power. Fitted with four Conway R.Co.11s type-tested at 17,250 lb. s.t., as opposed to four Sapphire A.S.Sa.7s in the Mk. 1, the later version has some 57% more thrust and a 10-ft. increase in span, bringing it up to 120 ft. The wing increase is in the form of a stub-wing increase inboard of the engines and a slight extension to the wing-tips.

To increase further their effectiveness both of these developed V-bombers are capable of carrying a stand-off bomb, the first of which is Blue Steel, designed to go into operational R.A.F. service in the early 1960s. Being built by Avro, Blue Steel is a relatively short-range supersonic cruise-type ASM capable of carrying a thermonuclear warhead and guided by inertial navigation. Later types of ASMs will have greater range and variable trajectory and improved methods of navigation.

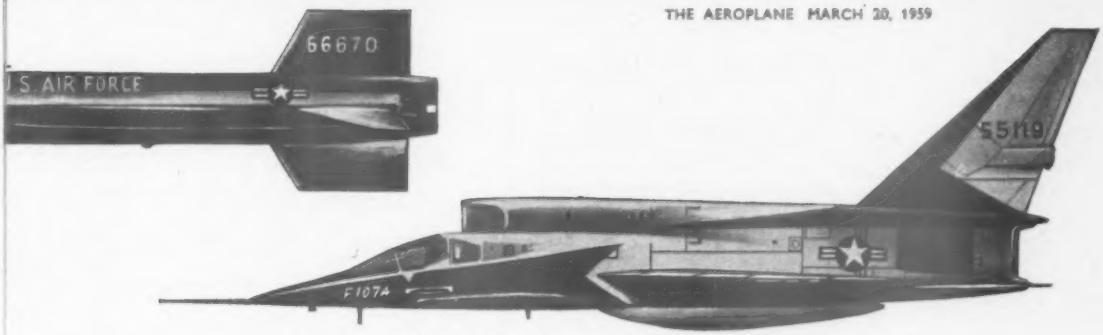
This development of powered bombs does not mean that the more conventional free-falling types will go out of service. Both kiloton and megaton free-falling nuclear weapons will be employed for certain types of target, especially where a very high degree of accuracy is required.

After a very hard fight the Air Staff obtained approval for the adoption of the important technique of air-to-air refuelling and the vast majority of the V-bombers in Bomber Command are now capable of becoming receiver aircraft. The tanker rôle is being filled by Vickers Valiants which are being replaced in the bomber and reconnaissance rôles by Vulcans and Victors. All the V-bomber types are capable of taking-off at their max. all-up weight and in-flight refuelling will therefore only be employed for extending their normal range and not for "topping-up" directly after take-off. An important use for flight refuelling which is not generally appreciated is in the ferrying of aircraft, particularly fighter aircraft, to different theatres of operation.

(Continued on page 341)



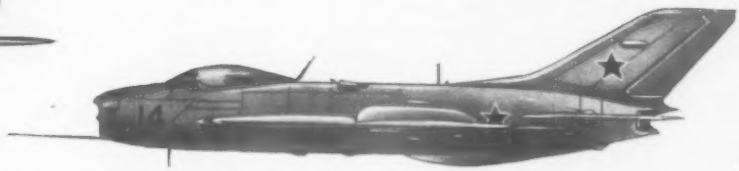
DEVELOPED VICTOR.—Latest of the deterrent V-bombers, the Handley Page Victor B.2 is specifically intended to carry the stand-off bomb.



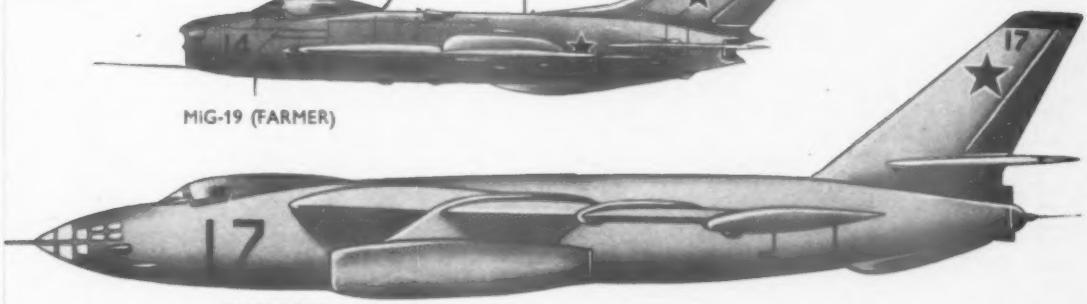
NORTH AMERICAN F-107A

NORTH AMERICAN A3J-1 VIGILANTE

SUKHOI DELTAS (FISHPOT Illustrated)



MiG-19 (FARMER)



BLOWLAMP

SAUNDERS-ROE S-R.53

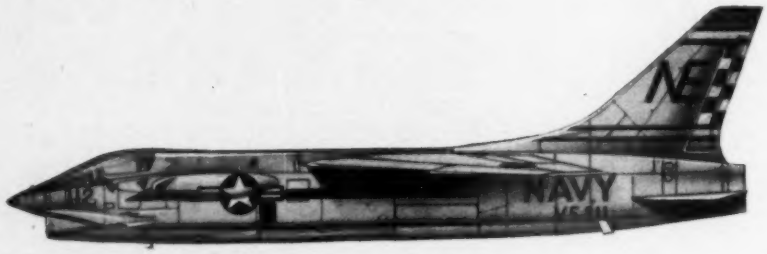
ENGLISH ELECTRIC LIGHTNING F.1

Drawings by Renée Boirac.

© Temple Press Limited 1959

LEVEL-FLIGHT SUPERSONIC AIRCRAF

Portrayed here to a common 1/144th scale are the 28 types of the World's aircraft believed to be currently flying and capable of sustained supersonic speed in level flight. Only single variants of each basic type are illustrated, and include three British, four French, one Swedish, five Soviet, and 15 American aircraft.



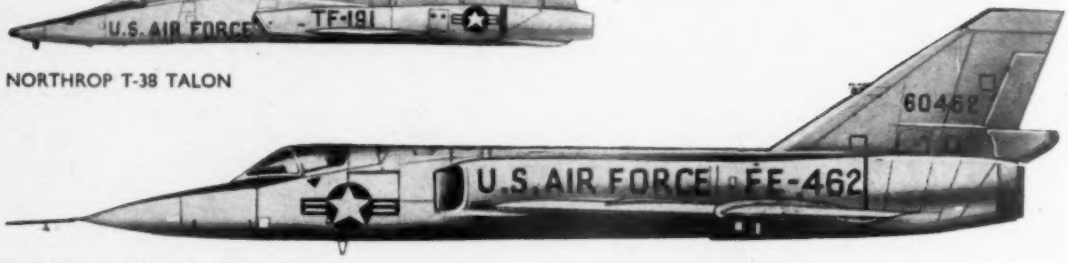
CHANCE VOUGHT F8U-1 CRUSADER

REPUBLIC F-105B THUNDERCHIEF

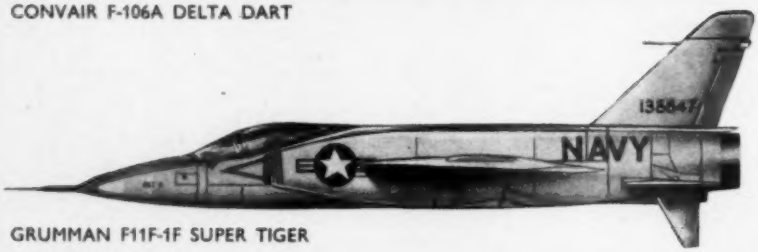
BELL X-IE

CONVAIR B-58 HUSTLER

NORTHROP T-38 TALON

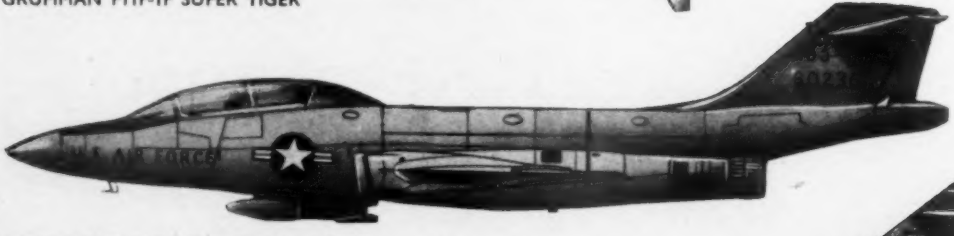


CONVAIR F-106A DELTA DART



GRUMMAN F11F-1F SUPER TIGER

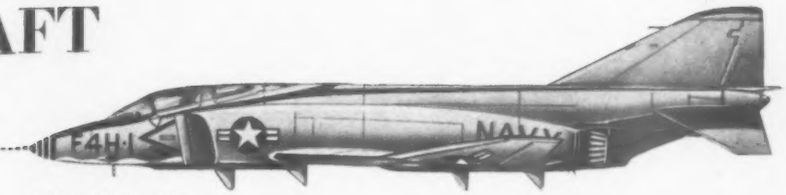
LOCKHEED F-104C STARFIG



McDONNELL F-101B VOODOO

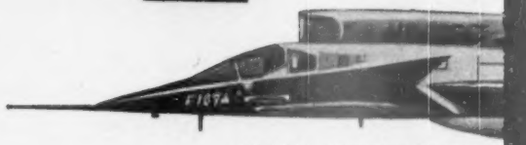
CONVAIR F-102A DELTA DAGGER

AFT

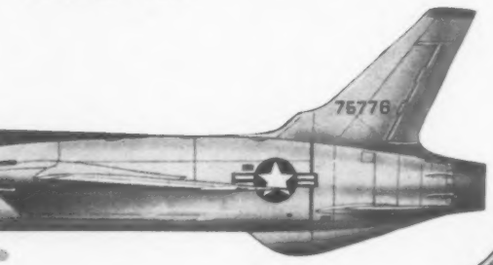


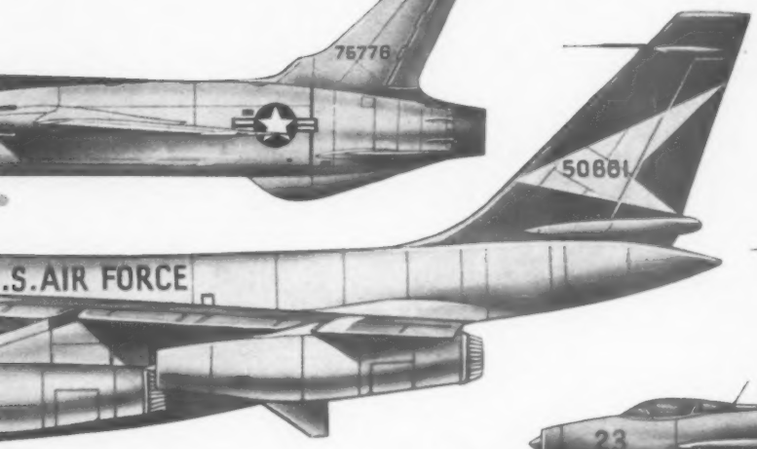
McDONNELL F4H-1

NORTH AMERICAN X-15



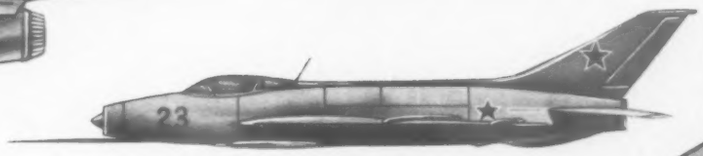
NORTH AMERICAN F-107A



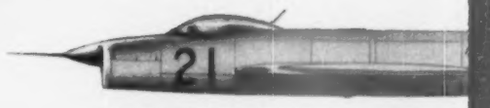


NORTH AMERICAN F-100D SUPER SABRE

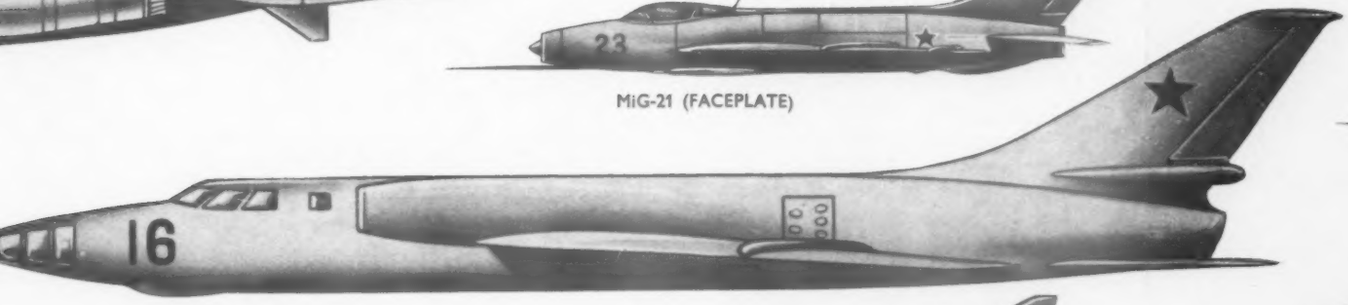
NORTH AMERICAN A3J-1 VIGILANTE



MiG-21 (FACEPLATE)



SUKHOI DELTAS (FISHPOT Illustrated)



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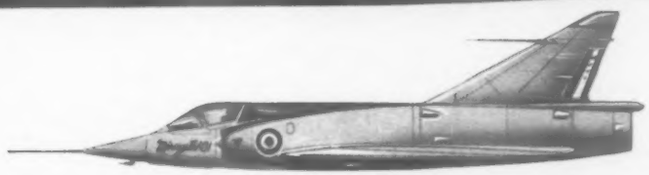
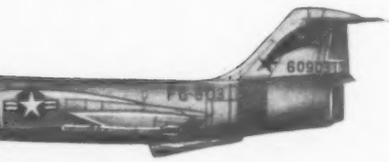
MiG-19 (FARMER)



DASSAULT MIRAGE IIIA



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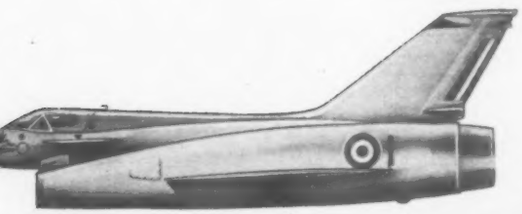
BLOWLAMP

DASSAULT ETENDARD IVM



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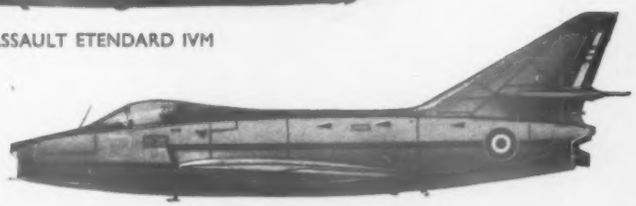
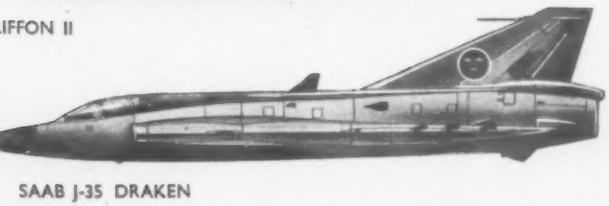


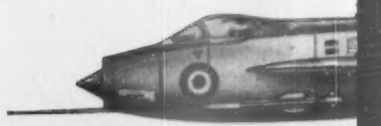
DASSAULT SUPER MYSTERE B.2

SAUNDERS-ROE S-R.53



SAAB J-35 DRAKEN

FAIREY F.D.2



ENGLISH ELECTRIC LIGHTNING F.1

Drawings by Re

GHT SUPERSONIC AIRCRAFT

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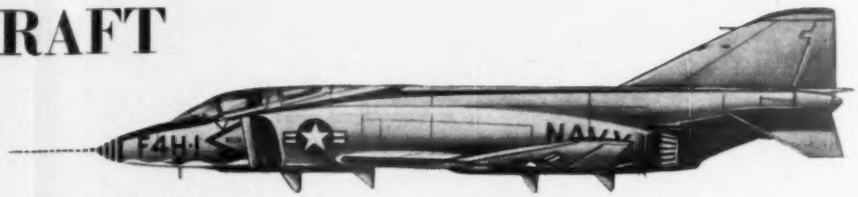
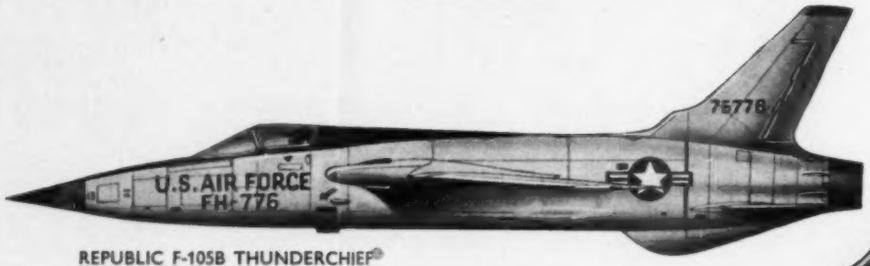


McDONNELL F4H-1



REPUBLIC F-105B THUNDERCHIEF®

CONVAIR B-58 HUSTLER

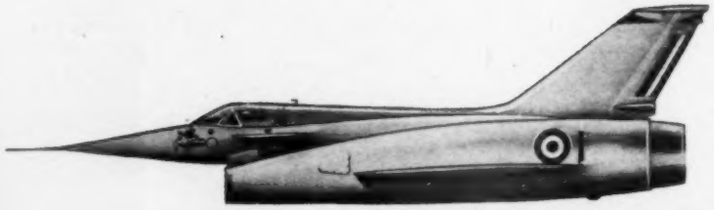
MiG-21 (FACEPLATE)

BACKFIN

LOCKHEED F-104C STARFIGHTER

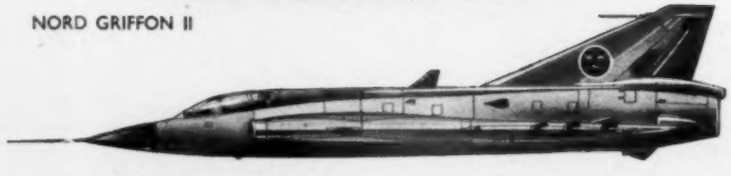
DASSAULT MIRAGE IIIA

DASSAULT ETENDARD IVM



DASSAULT SUPER MYSTERE

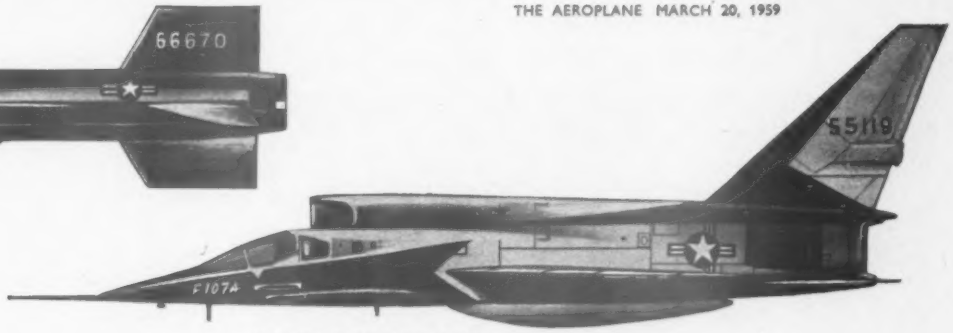
NORD GRIFFON II



SAAB J-35 DRAKEN

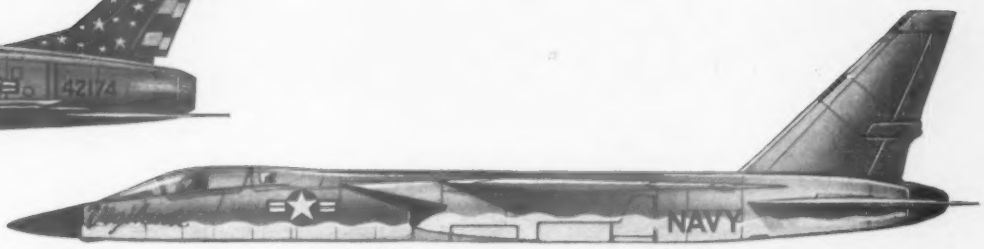
FAIREY F.D.2

NORTH AMERICAN X-15



NORTH AMERICAN F-107A

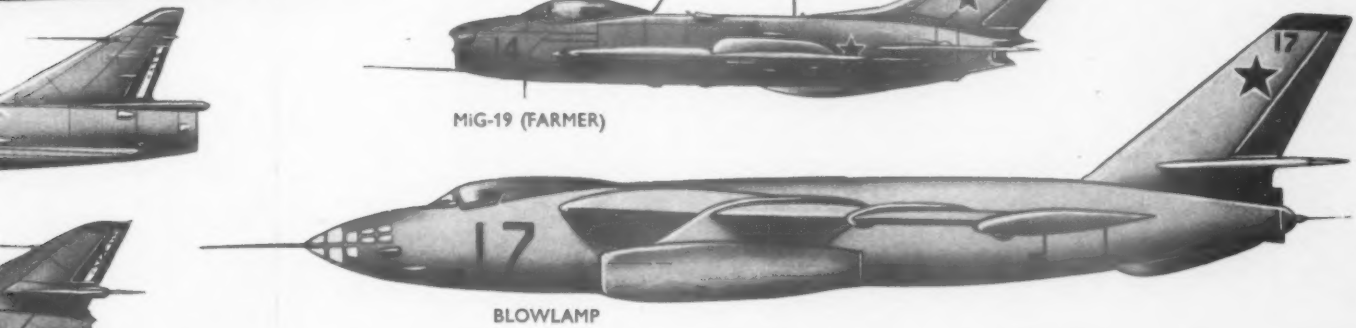
ERICAN F-100D SUPER SABRE



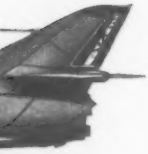
NORTH AMERICAN A3J-1 VIGILANTE

SUKHOI DELTAS (FISHPOT Illustrated)

MiG-19 (FARMER)



BLOWLAMP



TERE B.2

SAUNDERS-ROE S-R.53

.2

ENGLISH ELECTRIC LIGHTNING F.1

Drawings by Renée Boirac.

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Military Aircraft of the World

Aircraft	Duty	Status	Crew	Powerplant	Dimensions			Weights and Loading			Performance							
					Span	Length	Wing Area	Empty	Normal Take-off	Wing Loading	Max. Speed		Initial Climb	Service Ceiling	Take-off to 50 ft.	Typical Range		
					ft. in.	ft. in.	sq. ft.	lb.	lb.	lb./sq. ft.	m.p.h.	ft.	ft./min.	ft.	t.	miles	m.p.h.	ft.	gal.
AUSTRALIA																		
Commonwealth																		
CA-25 Winjeel	T.	Serv.	3	1×445-h.p. P. & W. R-985-AN2	38 7½	28 0½	249	1,492	4,265	17.1	186	S.L.	1,500	18,000	1,110	550	158	5,000	69
CA-27 Avon-Sabre	F.	Serv.	1	1×Avon 26	37 1	37 6	288	N.A.	15,800	54.9	700	S.L.	N.A.	45,000+	N.A.	1,700+	N.A.	N.A.	N.A.
CANADA																		
Avro																		
CF-100 Mk. 5	A.F.	Serv.	2	2×7,500-lb. Orenda II	60 10	54 2	591	N.A.	33,600	56.8	*650*	*10,000*	*8,500*	*55,000*	N.A.	*2,000*	N.A.	N.A.	N.A.
Canadair																		
Sabre 6	F.	Serv.	1	1×7,250-lb. Orenda 14	37 1½	37 6	288	11,143	16,426	57.0	710	S.L.	11,800	N.A.	N.A.	1,495	N.A.	N.A.	N.A.
CL-28 (CP-107) Argus	M.R.	Serv.	15	4×3,700-h.p. Wright R-3350	142 3½	128 3	2,075	81,000	148,000	71.3	288	S.L.	N.A.	20,000+	N.A.	4,000+	180	S.L.	7,188
CL-66 (CC-109) Canadair S40	Tp.	Prod.	2–4+48–58	2×3,360-h.p. Eland	105 4	81 6	920	32,980	53,200	57.8	N.A.	N.A.	N.A.	N.A.	N.A.	1,730	320	20,000	1,692
De Havilland																		
DHC-2 Beaver	Tp.	Serv.	1+7	1×450-h.p. P. & W. R-985	48 0	30 3	250	2,850	5,100	20.4	163	5,000	1,020	18,000	1,015	455	143	5,000	79
DHC-3 Otter	Tp.	Serv.	1+10	1×600-h.p. P. & W. R-1340-S1H1-G	58 0	41 10	375	4,168	8,000	21.3	160	5,000	735	18,800	1,310	960	138	5,000	178
DHC-4 Caribou	Tp.	Dev.	2+30	2×1,450-h.p. P. & W. R-2000-7M2	96 0	68 10	912	14,700	26,000	28.5	N.A.	N.A.	1,830	24,900	840	800	148	7,500	440
INDIA																		
Hindustan																		
HT-2	T.	Serv.	2	1×155-h.p. Cirrus Major III	35 2	24 8½	173.4	1,540	2,240	12.9	130	S.L.	800	14,500	N.A.	350	115	1,000	26
FRANCE																		
Breguet																		
765 Sahara	Tp.	Dev.	5+146	4×2,500-h.p. P. & W. R-2800 CB-17	140 5	94 11	1,996	68,343	119,050	59.6	N.A.	N.A.	1,080	N.A.	5,100	2,930	210	10,000	4,466
1001 Taon	F.B.	Dev.	1	1×4,850-lb. Orpheus 3	22 3½	38 4	158	5,700	11,000	69.6	740	S.L.	N.A.	N.A.	N.A.	*400*	450	1,000	N.A.
1050 Alizé	A.S.	Prod.	3	1×1,950-h.p. Dart R. Da.21	51 2	45 6	387.5	N.A.	17,640	45.5	285	S.L.	1,380	20,000	N.A.	700	140	1,000	462
Dassault																		
Mystère IVA	F.	Serv.	1	1×7,700-lb. Verdon 350	36 5½	42 1½	344.3	12,496	16,535	48.0	695	S.L.	8,850	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Super-Mystère B-2	F.	Prod.	1	1×9,700-lb. Atar 101G(R)	34 6	46 1	N.A.	15,400	19,840	N.A.	745	36,000	17,500	55,750	N.A.	N.A.	N.A.	N.A.	N.A.
Etendard IV-M	F.	Prod.	1	1×9,700-lb. Atar 8	31 6	47 3	285	N.A.	19,400	68.1	M=1.1	36,000	N.A.	N.A.	N.A.u	780	450	N.A.	335
Mirage III-A	F.	Dev.	1	1×13,230-lb. Atar 9(R)+1×3,700-lb. SEPR84	26 11	41 6	366	N.A.	13,000	35.5	M=2.0+	36,000	20,000	*70,000*+	N.A.	N.A.	N.A.	N.A.	N.A.
Max Holste																		
M.H.1521 Broussard	Tp.	Serv.	1+6	1×450-h.p. P. & W. R-985	45 1	28 4½	271.25	3,637	5,953	21.9	161	3,000	785	N.A.	1,300	745	142	3,000	97
Nord-Aviation																		
2501 Noratlas	Tp.	Serv.	5	2×2,040-h.p. Hercules 738 or 758	106 7	72 1	1,089	29,425	47,850	43.9	254	5,000	1,075	22,100	2,700	1,710	198	10,000	1,120
3202	T.	Prod.	2	1×240-h.p. Potez 4.D-32	32 1½	26 2½	177.5	1,813	2,495	14.1	161	S.L.	N.A.	N.A.	N.A.	620	N.A.	N.A.	N.A.
3400	O.	Prod.	2–3	1×260-h.p. Potez 4.D-34	41 8	27 8	210	2,028	2,975	14.2	147	S.L.	1,375	N.A.	320u	620	124	1,000	48.4
1500 Griffon II	Ex.	Dev.	1	1×ram jet and 1×7,500-lb. Atar 101E-3	26 7	47 8½	344.5	N.A.	14,550	42.2	*M=2.0*	36,000	N.A.	N.A.	3,280u	N.A.	N.A.	N.A.	N.A.
Potez-Air Fouga																		
Magister (Esquif similar)	T.	Serv.	2	2×880-lb. Marboré IIA	39 10	33 0	186.1	4,740	6,614	35.6	407	23,000	3,345	39,350	2,890	570	N.A.	N.A.	215
Sud-Aviation																		
S.E.3130 Alouette II	G.P.Hel.	Serv.	5	1×360-h.p. Artouste II	33 6°	31 9½	880°	1,875	3,300	3.75°	110	S.L.	880	10,500	—	373	106	S.L.	131
S.O.1221 Djinn	G.P.Hel.	Serv.	2	1×240-h.p. Palouste IV	36 1°	17 4	1,022°	794	1,765	1.73°	80	S.L.	690	N.A.	—	112	66	S.L.	55
S.O.4050 Vautour IIN	A.F.	Serv.	2	2×7,700-lb. Atar 101E-3	49 6½	51 1	484.4	23,150	33,070	68.3	685	S.L.	11,820	44,000	2,600u	1,500	N.A.	N.A.	N.A.
WEST GERMANY																		
Dornier																		
Do 27A	G.P.	Serv.	4	1×270-h.p. Lycoming GO-480-B1A6	39 4½	31 4	208.8	2,173	3,308	15.8	159	3,280	N.A.	19,700	540	565	118	3,280	46.2
ITALY																		
Fiat																		
F-86K (North American Licence)	A.F.	Serv.	1	1×7,350-lb. Gen. Elect. J47-GE-17 (R)	37 1	42 4	288	N.A.	18,000	62.5	720	S.L.	N.A.	45,000+	N.A.	1,000	N.A.	N.A.	N.A.
G.91	F.B.	Prod.	1	1×4,850-lb. Orpheus 3	28 1	34 2½	176.7	6,250	11,365	64.3	675	5,000	N.A.	N.A.	*3,280*	350	N.A.	N.A.	N.A.
Macchi																		
M.B.326	T.	Prod.	2	1×1,750-lb. Viper A.S.V.8	32 11	34 5	204.5	4,678	7,174	35.1	437	20,000	2,360	36,000	2,460	745	N.A.	N.A.	190
Piaggio																		
P.149-D	T.	Serv.	2	1×270-h.p. Lycoming GO-480	36 6	28 9½	203	2,557	3,704	18.2	192	S.L.	980	19,800	1,328	680	165	10,800	52.8
JAPAN																		
Fuji																		
TIF2	T.	Dev.	2	1×4,130-lb. Orpheus B.Or. 1	34 5½	39 8½	239.2	N.A.	8,800	36.8	557	20,000	6,100	40,000	2,350	783	330	30,000	504
SPAIN																		
Casa																		
201 Alcotan	Tp.	Serv.	2+10	2×500-h.p. Sirio-VIIA	60 4	45 3	450	7,920	12,100	26.8	219	S.L.	N.A.	20,000	N.A.	621	193	6,500	N.A.
Hispano																		
HA-100-E1 Triana	T.	Prod.	2	1×755-h.p. Beta B-4	34 1	29 5	186.6	4,343	6,460	34.6	276	9,500	2,130	33,600	N.A.	821	237	9,500	132
HA-200-R1 Saeta	T.	Dev.	2	2×880-lb. Marboré IIA	34 2	29 1½	187.2	3,697	6,995	37.4	405	S.L.	3,345	39,350	N.A.	1,056	N.A.	32,800	270
SWEDEN																		
Saab																		
J29F	F.	Serv.	1	1×6,500-lb. Ghost 50 (R)	36 1	33 2½	258	*10,000*	*14,000*	54.2	658	5,000	15,000	N.A.	N.A.	1,677	N.A.	N.A.	Ext. tanks
A32A Lansen	F.B.	Serv	2	1×10,000-lb. RM5 (Avon) (R)	42 8	49 2½	402.5	*15,400*	*22,000*	N.A.	*700*	S.L.	N.A.	N.A.	N.A.	2,000+	N.A.	N.A.	N.A.
J35A Draken	F.	Prod.	1	1×14,500-lb. RM6 (Avon) (R)	30 10	46 7	538.2	N.A.	20,150	37.4	M=1.8	36,000	*39,350*	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
91-D Safir	T.	Serv.	4	1×180-h.p. Lycoming O-360-A1A	34 9	26 0	146.3	N.A.	2,657	18.1	165	S.L.	N.A.	16,400	N.A.	620	146	3,000	38.5
SWITZERLAND																		
Pilatus																		
P-3	T.	Prod.	2	1×260-h.p. Lycoming GO-435-C2A	34 1	28 8	177	2,447	3,120	17.7	192.5	S.L.	1,380	18,040	1,120	465	157	5,000	35.2
UNITED KINGDOM																		
Armstrong Whitworth																		
A.W.660 (data apply to A.W.650)	Tp.	Prod.	3+83	4×2,100-h.p. Dart Mk. 526	115 0	86 9	1,458	20,885	82,000	56.0	N.A.	N.A.	*1,400*	N.A.	*3,200*	2,800	276	25,000	3,300
Sea Hawk FGA.6	F.B.	Serv.	1	1×5,400-lb. Nene RN.6 Mk. 103	39 0	39 8	278	N.A.	16,200	58.3	599	S.L.	5,700	N.A.	3,765	580	N.A.	N.A.	N.A.
Auster																		
AOP.9	O.	Serv.	3	1×173-h.p. Bombardier 203	36 5	23 8½	197.6	1,590	2,125	10.4	127	S.L.	970	19,500	675	242	110	1,000	15
Avro																		
Shackleton MR.3	M.R.	Serv.	10	4×2,455-h.p. Griffon 57A	119 10	92 6	1,421	N.A.	100,000	70.4	300	12,000	850	19,200	3,820	3,660	200	1,500	4,248
Vulcan B.2	B.	Prod.	5	4×17,000-lb. Olympus 201	111 0	97 1	N.A.	N.A.	*180,000*+	N.A.	600+	50,000	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Blackburn																		
Beverley C.1	Tp.	Serv.	4+94	4×2,850-h.p. Centaurus 173	162 0	99 5	2,916	82,100	135,000	46.4	238	5,700	760	16,000	1,340	1,063	173	12,500	N.A.
NA.39	S.	Prod.	2	2×Gyron Junior	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	*1,400*	N.A.	N.A.	N.A.
Bristol																		
Britannia C.1	Tp.	Serv.	4–7+115	4×4,445-h.p. Proteus 255	142 3½	124 3	2,075	88,250	180,000	86.7	N.A.	N.A.	N.A.	N.A.	7,200	5,310	357	23,000	8,486

NA.39	S.	Prod.	2	2×Gyron Junior	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,400	N.A.	N.A.	N.A.
Bristol																									
Britannia C.1	Tp.	Serv.	4–7+115	4×4,445-h.p. Proteus 255	142 3½	124 3	2,075	88,250	180,000	86.7	N.A.	N.A.	N.A.	N.A.	7,200	5,310	357	23,000	8,486
Sycamore HR.14	G.P.Hel.	Serv.	1+4	1×520-h.p. Leonides 524/1	48 7*	46 2	1,856*	3,965	5,600	2.9*	127	S.L.	1,200	14,500	—	268	91	2,000	65
Type 192	G.P.Hel.	Prod.	2+18	2×1,650-h.p. Gazelle N.Ga.2	48 8*	89 9½	2×1,860*	10,481	18,000	4.84*	N.A.	N.A.	1,180	13,250	—	432	138	S.L.	560
De Havilland																									
Sea Venom FAW.22	A.F.	Serv.	2	1×5,300-lb. Ghost Mk. 105	42 10	36 8	279.8	N.A.	15,800	56.5	575	S.L.	5,900	40,000	4,230	705	—	35,000	561
Sea Vixen FAW.1	A.F.	Prod.	2	2×10,000-lb. Avon 200 Series	50 0	53 6½	N.A.	N.A.	35,000	N.A.	690	10,000	10,000+	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Vampire T.11	T.	Serv.	2	1×3,500-lb. Goblin 35	38 0	34 6½	261	—	11,150	42.7	549	20,000	4,500	40,000	2,730	850	403	40,000	—
English Electric																									
Canberra B(I).8	B.	Serv.	2	2×7,500-lb. Avon 109	63 11½	65 6	960	N.A.	45,000+	N.A.	580	40,000	N.A.	55,000	N.A.	3,000	N.A.	N.A.	Ext. tanks
Lightning F.1	A.F.	Prod.	1	2×17,250-lb. Avon R.A.24R (R)	34 10	50 0	N.A.	N.A.	N.A.	N.A.	M=2+	40,000	N.A.	60,000+	N.A.	N.A.	N.A.	N.A.	N.A.
Fairey																									
Delta 2	Ex.	Dev.	1	1×Avon 200 Series (R)	26 10	51 7½	360	N.A.	N.A.	N.A.	M=1.7+	40,000	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Gannet AEW.3	E.W.	Prod.	3	1×3,875-h.p. Double Mamba ASMD.8	54 4	44 0	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Folland																									
Gnat Mk. 1	F.	Prod.	1	1×4,520-lb. Orpheus 2	22 2	29 9	136.6	4,850	6,575	48.1	695	20,000	20,000	50,000+	2,190	920	N.A.	N.A.	332
Gloster																									
Javelin FAW.8	A.F.	Prod.	2	2×12,300-lb. Sapphire 200 Series (R)	52 0	56 9	N.A.	N.A.	32,000+	N.A.	710	10,000	12,000+	55,000	N.A.	N.A.	N.A.	N.A.	N.A.
Handley Page																									
Hastings C.2	Tp.	Serv.	5+50	4×1,675-h.p. Hercules 106	113 0	81 8	1,408	48,427	80,000	56.8	348	22,200	890	26,500	1,586	4,250	—	—	3,172
Victor B.2	B.	Prod.	5	4×17,250-lb. Conway R.Co.11	120 0	114 11	N.A.	N.A.	N.A.	N.A.	600+	50,000	N.A.	55,000+	N.A.	N.A.	N.A.	N.A.	N.A.
Hawker																									
Hunter F.6	F.	Serv.	1	1×Avon 200 Series	33 8	45 10½	349	13,500	17,800	N.A.	700+	S.L.	15,000	55,000	N.A.	550	N.A.	N.A.	410
Hunting																									
Jet Provost T.3	T.	Prod.	2	1×1,750-lb. Viper 102	36 11	32 5	213.7	4,347	7,092	33.2	329	30,000	2,380	35,000	1,990	565	273	25,000	286
Pembroke C.1	Tp.	Serv.	2+8	2×550-h.p. Leonides 127	64 6	46 0	400	9,178	13,500	33.8	224	2,000	1,070	22,000	2,520	1,150	155	8,000	232
Provost T.1	T.	Serv.	2	1×550-h.p. Leonides 126	35 2	28 8	214	3,350	4,400	20.6	200	2,300	2,200	22,500	850	650	162	5,000	66
Saunders-Roe																									
Skeeter 12	G.P.Hel.	Serv.	2	1×215-h.p. Gipsy Major 215	32 0*	26 8	805*	1,656	2,200	2.73*	104	S.L.	1,150	12,800	—	185	86	1,000	23
Scottish Aviation																									
Pioneer CC.1	G.P.	Serv.	1+4	1×540-h.p. Leonides 502/4	49 9	34 4½	390	4,230	5,800	14.9	145	1,500	1,148	15,850	800	805	115	5,000	128
Twin Pioneer CC.1	Tp.	Serv.	2+16	2×540-h.p. Leonides 514/8	76 6	45 3	670	9,502	13,500	20.1	165	1,450	970	17,000	1,272	925	117	5,000	247
Supermarine																									
Scimitar F.1	F/S	Serv.	1	2×11,250-lb. Avon 200 Series	37 2	55 4	N.A.	N.A.	40,000	N.A.	710	10,000	12,000+	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Swift FR.5	F.R.	Serv.	1	1×9,450-lb. Avon 114 (R)	32 4	42 3	306	N.A.	21,400	69.9	685	S.L.	N.A.	N.A.	N.A.	475	N.A.	N.A.	N.A.
Vickers-Armstrongs																									
Valiant B (K).1	B.	Serv.	5	4×10,000-lb. Avon 204	114 4	108 3	2,362	N.A.	160,000	N.A.	600+	40,000	5,000+	45,000+	N.A.	N.A.	N.A.	N.A.	N.A.
Westland																									
Wessex	A.S.Hel.	Prod.	5–6	1×1,450-h.p. Gazelle N.Ga.13	56 0*	56 7½	2,460*	8,350	12,600	5.13*	144	S.L.	1,650	17,000	—	340	115	S.L.	260
Whirlwind HAS.7	A.S.Hel.	Serv.	4–5	1×715-h.p. Leonides Major 755/4	53 0*	41 8	2,210*	5,375	7,800	3.53*	109	S.L.	1,200	13,200	—	334	86	S.L.	145
U.S.A.																									
Beech																									
L-23D Seminole	L.	Serv.	1+5	2×340-h.p. Lycoming G50–480–B1 B6	45 3½	31 6½	277	4,460	7,000	25.2	240	9,000	1,620	24,800	1,250	1,650	169	10,000	192
T-34B Mentor	T.	Serv.	2	1×225-h.p. Continental O-470-13	32 10	25 11	177.6	2,254	2,985	16.75	188	S.L.	1,160	19,500	1,200	728	170	10,000	41.6
Bell																									
H-13H Sioux	G.P.Hel.	Serv.	3	1×200-h.p. Lycoming VO–435	35 1½*	31 4	965*	1,564	2,450	2.54*	100	S.L.	1,065	14,950	—	238	85	1,000	36
HU–1A Iroquois	G.P.Hel.	Prod.	1+5	1×700-h.p. Lycoming T53–L–1	44 0	53 0	1,520*	3,791	5,800	3.80*	141	S.L.	2,100	N.A.	N.A.	202	115	1,000	—
X–1E	Ex.	Dev.	1	1×12,000-lb. Reaction Motors XLR11	28 0	34 6	130	4,890	13,069	100.5	M=2.5	36,000	N.A.	N.A.	—	N.A.	N.A.	N.A.	N.A.
Boeing																									
DB–47E Stratojet	B.	Serv.	3	6×6,000-lb. Gen. Elect. J47–GE–25	116 0	109 10	N.A.	N.A.	175,000	N.A.	630	10,000	N.A.	42,000	N.A.	3,200	495	40,000	N.A.
B-52G Stratofortress	B.	Prod.	6	8×11,000-lb. P. & W. J57–P–43W	185 0	157 7	4,000	N.A.	450,000	N.A.	650	20,000	N.A.	50,000	N.A.	10,000	N.A.	N.A.§	N.A.
KC–97G Stratofreighter	Tan/T.	Serv.	5+65	4×3,250-h.p. P. & W. R–4360–59B	141 3	110 4	1,769	82,500	153,000	86.5	375	10,000	N.A.	35,000+	N.A.	4,300	300	20,000	7,790
KC–135A Stratotanker	Tan/T.	Serv.	N.A.	4×11,800-lb. P. & W. J57–P–31	130 10	136 3	2,433	N.A.	250,000+	N.A.	642	10,000	N.A.	45,000	N.A.	N.A.	N.A.	N.A.	14,488
Cessna																									
L–19E Bird Dog	O/L.	Serv.	2	1×213-h.p. Continental O–470–11	36 0	25 10	174	1,614	2,430	13.79	115	1,000	1,150	18,500	560	530	104	5,000	34
L–27A	L.	Serv.	1+4	2×240-h.p. Continental O–470–M	35 9	27 5	175	3,146	4,830	27.6	230	S.L.	1,590	20,000	N.A.	1,250	211	8,000	111
T–37A	T.	Serv.	2	2×920-lb. Continental J69–T–9	33 10	29 3	183.9	3,890	6,403	34.82	388	35,000	N.A.	36,400	N.A.	815	308	35,000	257
Chance Vought																									
F8U–1 Crusader	F.	Serv.	1	1×16,200-lb. P. & W. J57–P–12 (R)	35 8	54 2½	N.A.	16,500	27,000	N.A.	M=1.7	36,000	15,000	54,000	N.A.	560	N.A.	N.A.	N.A.
Convair																									
B–58A Hustler	B.	Prod.	3	4×16,000-lb. Gen. Elect. J79 (R)	57 0	97 6	N.A.	N.A.	160,000	N.A.	M=2	36,000	N.A.	60,000	N.A.	N.A.	N.A.	N.A.	N.A.
C–131A Samaritan	Tp.	Serv.	3+37	2×2,500-h.p. P. & W. R–2800–99W	91 9	74 8	817	29,000	43,575	53.3	313	10,000	1,410	24,500	3,300	1,600	N.A.	N.A.	1,274
F–102A Delta Dagger	A.F.	Serv.	1	1×17,000-lb. P. & W. J57–P–35 (R)	38 1½	68 3	661.5	N.A.	27,000	N.A.	M=1.25	36,000	12,000	54,000	N.A.	N.A.	N.A.	N.A.	N.A.
F–106A Delta Dart	A.F.	Prod.	1	1×23,500-lb. P. & W. J75–P–4 (R)	38 1½	70 8½	661.5	N.A.	N.A.	N.A.	M=2	40,000	N.A.	60,000	N.A.	N.A.	N.A.	N.A.	N.A.
Douglas																									
AD–7 Skyraider	S.	Serv.	1	1×2,700-h.p. Wright R–3350–26WB	50 9	39 0	400.3	12,094	19,000	47.5	365	15,000	2,850	25,000+	N.A.	3,000	N.A.	N.A.	565
A3D–2 Skywarrior	B.	Serv.	3	2×10,500-lb. P. & W. J57–P–10	72 6	73 6	730	38,000	70,000	95.9	610	S.L.	N.A.	43,000	N.A.	2,000+	N.A.	N.A.	N.A.
A4D–2 Skyhawk	S.	Serv.	1	1×7,800-lb. Wright J65–W–4	27 6	39 4½	260	8,300	15,500	59.6	670	S.L.	N.A.	N.A.	N.A.	920	N.A.	N.A.	641
B–66B Destroyer	B.	Serv.	3	2×10,200-lb. Allison J71–A–11	72 6	75 2	780	40,330	78,000	100.0	620	18,000	N.A.	40,000+	N.A.	1,500+	N.A.	N.A.	3,872
C–124C Globemaster II	Tp.	Serv.	5+200	4×3,800-h.p. P. & W. R–4360–63A	174 1½	130 5	2,506	101,165	185,000	73.8	304	20,800	760	22,100	N.A.	6,280	264	13,600	9,160
C–133A Cargomaster	Tp.	Serv.	6+200+	4×6,000-h.p. P. & W. T34–P–7W	179 8	157 6½	2,673.1	116,191	275,000	102.9	355	20,000	1,000	N.A.	5,000u	4,030	310	20,000	13,740
F4D–1 Skyray	F.	Serv.	1	1×13,500-lb. P. & W. J57–P–2 (R)	33 6	45 8¼	557	N.A.	20,000	35.9	720	S.L.	16,000	48,000	N.A.	950	N.A.	N.A.	Ext. tanks
Fairchild																									
C–123B Provider	Tp.	Serv.	2+60	2×2,500-h.p. P. & W. R–2800–99W	110 0	76 3	1,223.2	31,058	56,500	49.0	245	10,000	1,150	23,000	N.A.	1,340	186	10,000	N.A.
Grumman																									
F9F–8T Cougar	F/T.	Serv.	2	1×7,250-lb. P. & W. J48–P–8A	34 6	44 5	N.A.	N.A.	20,000	N.A.	700	S.L.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
F11F–1 Tiger	F.	Serv.	1	1×11,000-lb. Wright J65–W–6 (R)	31 7½	44 6	N.A.	N.A.	13,850	N.A.	M=1.35	36,000	14,000	55,000	N.A.	600	N.A.	N.A.	N.A.
F11F–1F Super Tiger	F.	Dev.	1	1×15,560-lb. Gen. Elect. J79–GE–7 (R)	31 7½	48 9	249.72	N.A.	15,000	N.A.	M=2.03	40,000	22,960	59,000	1,395u	525	N.A.	N.A.	N.A.
SA–16B Albatross	Res.	Serv.	4+10	2×1,425-h.p. Wright R–1820–76A	96 6	62 4	N.A.	25,600	32,100	N.A.	277	—	—	—	—	—	230	—	—
S2F–1 Tracker	A.S.	Serv.	4	2×1,525-h.p. Wright R–1820–82	69 8	42 3	485	N.A.	21,000	43.3	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Hayes-Boeing																									
KB–50J Superfortress	Tan/T.	Serv.	N.A.	4×3,500-h.p. P. & W. R–4360–35+2×6,000-lb. J47	141 3	105 0	1,768	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Hiller																									
H–23D Raven	G.P.Hel.	Serv.	3	1×250-h.p. Lycoming VO–435–A1C	35 6*	27 9½	985*	1,780	2,700	2.74*	95	S.L.	1,050	13,200	—	205	82	1,000	40
Kaman																									
HOK–1 (and H–43A)	G.P.Hel.	Serv.	1+3–4	1×600-h.p. P. & W. R–1340–48	47 0	25 0	3,470*	4,040	5,800	1.67*	109	8,000	1,300	18,000	—	220	75	1,000	83.3
H–43B Huskie	Res.Hel.	Prod.	1+7	1×860 h.p. Lycoming T53	47 0	25 0	3,470*	4,198	7,250	2.1	132+	N.A.	N.A.	N.A.	—	264	N.A.	N.A.	160
Lockheed																									
C–130B Hercules	Tp.	Prod.	4+92	4×4,000-h.p. Allison T56–A–7A	132 7	97 8	1,745	69,300	135,000	77.3	N.A.	N.A.	2,450	35,000+	4,200	4,000	350	20,000	5,745
F–104C Starfighter	F.	Serv.	1	1×15,560-lb. Gen. Elect. J79–GE–7 (R)	21 11	54 9	179	N.A.	17,000	N.A.	M=2.2	40,000	15,000+	60 000	N.A.	N.A.	N.A.	N.A.	N.A.
P2V–7 Neptune	M.R.	Serv.	7	2×3,500-h.p. Wright R–3350–32W+2×3,400-lb. Westinghouse J34	103 10	91 8	1,000	47,450	75,500	75.5	356	10,000	N.A.	22,000	N.A.	3,700	N.A.	N.A.	1,832
T–33A	T.	Serv.	2	1×5,200-lb. Allison J33–A–35	38 10½	37 9	237	8,400	11,965	50.5	540	S.L.	4,680	47,500	2,560	1,345	N.A.	N.A.	Ext. tanks
T2V–1 Seastar	T.	Serv.	2	1×6,100-lb. Allison J33–A–22	42 10	38 6½	N.A.	11,500	15,500	N.A.	580	35,000	5,400	40,000	N.A.	900	N.A.	N.A.	633
WV–2 (and RC–121C)	E.W.	Serv.	31	4×3,500-h.p. Wright R–3350–34	123 0	116 2	1,650	N.A.	140,000	84.8	305	20,000	N.A.	N.A.	N.A.	N.A.	245	N.A.	5,454
McDonnell																									
F–101C Voodoo	F.	Serv.	1	2×14,500-lb. P. & W. J57–P–13 (R)	39 8½	67 4½	N.A.	28,000	40,000	N.A.	M=1.85	40,000	14,000	52,000	N.A.	3,000	595	36,000	Ext. tanks
F3H–2N Demon	A.F.	Serv.	1	1×14,250-lb. Allison J71–A–2 (R)	35 4	58 4	500	N.A.	30,000	N.A.	730	S.L.	12,000	N.A.	N.A.	1,500	N.A.	N.A.	N.A.
F4H–1	A.F.	Dev.	2	2×16,000-lb. Gen. Elect. J79 (R)	38 5	56 0	N.A.	N.A.	40,000+	N.A.	M=2	40,000	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Martin																									
B–57B	B.	Serv.	2	2×7,220-lb. Wright J65–W–5	64 0	65 6	960	30,000	49,500	N.A.	620	35,000	N.A.	48,000	N.A.	2,300	N.A.	N.A.	N.A.
P5M–2 Marlin	M.R.	Serv.	7	2×3,400-h.p. Wright R–3350–32W	118 2½	101 9½	1,406.3	49,480	74,442	52.9	245	S.L.	N.A.	22,400	N.A.	2,050	N.A.	N.A.	2,339
North American																									
A3J–1 Vigilante	B.	Prod.	2	2×15,000-lb. Gen. Elect. J79–GE–2 (R)	50 0	70 0	N.A.	N.A.	49,500	N.A.	M=2+	40,000	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
F–100C Super Sabre	F.B.	Serv.	1	1×16,000-lb. P. & W. J57–P–21 (R)	38 0	47 0	N.A.	N.A.	28,000	N.A.	M=1.2	35,000	N.A.	50,000+	4,500u	1,150	N.A.	N.A.	1,450
F–107A	Ex.	Dev.	1	1×P. & W. J75 (R)	36 7	60 10	N.A.	N.A.	N.A.	N.A.	M=2+	40,000	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
FJ–4B Fury	F.B.	Serv.	1	1×7,700-lb. Wright J65–W–16A	39 1	37 6	N.A.	N.A.	26,000	N.A.	715	S.L.	8,000	45,000+	N.A.	N.A.	N.A.	N.A.	N.A.
T–28B	T.	Serv.	2	1×1,425-h.p. Wright R–1820	40 7	32 9	268	6,424	8,004	29.0	346	S.L.	3,830	37,000	1,140	1,060	250	10,000	104
T2J–1	T.	Prod.	2	1×3,400-lb. Westinghouse J34–WE–36	36 0	38 4	255	N.A.	9,507	37.3	494	25,000	5,000	41,000	2,010	967	422	40,000	484
X–15	Ex.	Dev.	1	1×50,000-lb. Reaction Motors XLR–99	22 0	50 0	200	N.A.	31,276	156.4	3,600	N.A.	N.A.	530,000	—	N.A.	N.A.	N.A.	N.A.
Northrop																									
F–89H Scorpion	A.F.	Serv.	2	2×7,200-lb. Allison J35–A–35 (R)	59 8	53 10	562	N.A.	41,000	N.A.	630	S.L.	N.A.	51,000	N.A.	1,700	N.A.	N.A.	N.A.
T–38 Talon	T.	Prod.	2	2×3,700-lb. Gen. Elect. J85 (R)	25 3	42 8	170	N.A.	10,960	64.5	M=1.28	35,000	N.A.	55,000	N.A.	1,200	N.A.	N.A.	N.A.
Republic																									
F–84F Thunderstreak	F.B.	Serv.	1	1×7,200-lb. Wright J65–W–3	33 7½	43 4½	N.A.	N.A.	26,030	N.A.	720	S.L.	7,500	48,000	N.A.	1,700	N.A.	N.A.	Ext. tanks
F–105B Thunderchief	F.B.	Serv.	1	1×23,500-lb. P. & W. J75–P–5 (R)	34 11	63 1	N.A.	N.A.	40,000	N.A.	M=2+	35,000	N.A.	50,000	N.A.	2,000+	N.A.	N.A.	Ext. tanks
Sikorsky																									
H–37A (and HR2S–1) Mojave	Tp.Hel.	Serv.	3+23	2×1,725-h.p. P. & W. R–2800–50	72 0*	82 10	4,070*	20,690	30,188	7.42*	130	S.L.	990	8,700	—	138	115	1,000	250
H–34A Choctaw (and HSS–1, HUS–1)	G.P.Hel.	Serv.	2+14	1×1,525-h.p. Wright R–1820–84	56 0*	47 2	2,460*	7,646	11,867	4.82*	134	S.L.	1,500	12,000	—	225	101	1,000	165
Temco																									
TT–1 Pinto	T.	Serv.	2	1×920-lb. Continental YJ69–T–9	29 10	30 7	150	3,139	4,400	29.3	345	15,000	1,900	32,200	2,995	405	270	25,000	103
Vertol																									
HUP–2 Retriever (and H–25A)	G.P.Hel.	Serv.	2+4	1×550-h.p. Continental R–975–46	35 0*	32 0	2×960*	4,132	5,750	3.0*	105+	S.L.	1,000	10,000+	—	340	80+	1,000	N.A.
H–21B Shawnee	G.P.Hel.	Serv.	2+20	1×1,425-h.p. Wright R–1820–103	44 0*	52 6	2×1,520*	8,800	13,500	4.44*	127	S.L.	1,050	N.A.	—	280	101	1,000	250
U.S.S.R.																									
Ilyushin																									
Il–28 ("Beagle")	B.	Serv.	4	2×5,955-lb. VK–1	68 0	62 8	N.A.	26,000	38,000	N.A.	580	S.L.	2,950	41,000	N.A.	1,600	450	35,000	2,620
Mikoyan/Gurevich																									
MiG–15bis ("Fagot")	F.	Serv.	1	1×5,955-lb. VK–1	33 1½	36 4	255	8,320	11,085	43.5	700	S.L.	10,400	49,000	N.A.	N.A.	N.A.	N.A.	N.A.
MiG–17 ("Fresco-C")	F.	Serv.	1	1×7,590-lb. VK–1A (R)	36 0	38 0	265	9,850	13,200	50.0	640	S.L.	10,500	52,100	N.A.	1,360	N.A.	N.A.	639

FRANCE																							
Breguet																							
765 Sahara	Tp.	Dev.	5+146	4×2,500-h.p. P. & W. R-2800 CB-17	140	5	94	11	1,996	68,343	119,050	59.6	N.A.	N.A.	1,080	N.A.	5,100	2,930	210	10,000	4,466
1001 Taon	F.B.	Dev.	1	1×4,850-lb. Orpheus 3	22	3½	38	4	158	5,700	11,000	69.6	740	S.L.	N.A.	N.A.	N.A.	400	450	1,000	N.A.
1050 Alizé	A.S.	Prod.	3	1×1,950-h.p. Dart R. Da.21	51	2	45	6	387.5	N.A.	17,640	45.5	285	S.L.	1,380	20,000	N.A.	700	140	1,000	462
Dassault																							
Mystère IVA	F.	Serv.	1	1×7,700-lb. Verdon 350	36	5½	42	1½	344.3	12,496	16,535	48.0	695	S.L.	8,850	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Super-Mystère B-2	F.	Prod.	1	1×9,700-lb. Atar 101G(R)	34	6	46	1	N.A.	15,400	19,840	N.A.	745	36,000	17,500	55,750	N.A.	N.A.	N.A.	N.A.	N.A.
Etendard IV-M	F.	Prod.	1	1×9,700-lb. Atar 8	31	6	47	3	285	N.A.	19,400	68.1	M=1.1	36,000	N.A.	N.A.	N.A.u	780	450	N.A.	335
Mirage III-A	F.	Dev.	1	1×13,230-lb. Atar 9(R)+1×3,700-lb. SEPR84	26	11	41	6	366	N.A.	13,000	35.5	M=2.0+	36,000	20,000	70,000+	N.A.	N.A.	N.A.	N.A.	N.A.
Max Holste																							
M.H.1521 Broussard	Tp.	Serv.	1+6	1×450-h.p. P. & W. R-985	45	1	28	4½	271.25	3,637	5,953	21.9	161	3,000	785	N.A.	1,300	745	142	3,000	97
Nord-Aviation																							
2501 Noratlas	Tp.	Serv.	5	2×2,040-h.p. Hercules 738 or 758	106	7	72	1	1,089	29,425	47,850	43.9	254	5,000	1,075	22,100	2,700	1,710	198	10,000	1,120
3202	T.	Prod.	2	1×240-h.p. Potez 4.D-32	32	1½	26	2½	177.5	1,813	2,495	14.1	161	S.L.	N.A.	N.A.	N.A.	620	N.A.	N.A.	N.A.
3400	O.	Prod.	2-3	1×260-h.p. Potez 4.D-34	41	8	27	8	210	2,028	2,975	14.2	147	S.L.	1,375	N.A.	320u	620	124	1,000	48.4
1500 Griffon II	Ex.	Dev.	1	1×ram jet and 1×7,500-lb. Atar 101E-3	26	7	47	8½	344.5	N.A.	14,550	42.2	M=2.0	36,000	N.A.	N.A.	3,280u	N.A.	N.A.	N.A.	N.A.
Potez-Air Fouga																							
Magister (Esquif similar)	T.	Serv.	2	2×880-lb. Marboré IIA	39	10	33	0	186.1	4,740	6,614	35.6	407	23,000	3,345	39,350	2,890	570	N.A.	N.A.	215
Sud-Aviation																							
S.E.3130 Alouette II	G.P.Hel.	Serv.	5	1×360-h.p. Artouste II	33	6*	31	9½	880*	1,875	3,300	3.75*	110	S.L.	880	10,500	—	373	106	S.L.	131
S.O.1221 Djinn	G.P.Hel.	Serv.	2	1×240-h.p. Palousse IV	36	1*	17	4	1,022*	794	1,765	1.73*	80	S.L.	690	N.A.	—	112	66	S.L.	55
S.O.4050 Vautour IIN	A.F.	Serv.	2	2×7,700-lb. Atar 101E-3	49	6½	51	1	484.4	23,150	33,070	68.3	685	S.L.	11,820	44,000	2,600u	1,500	N.A.	N.A.	N.A.
WEST GERMANY																							
Dornier																							
Do 27A	G.P.	Serv.	4	1×270-h.p. Lycoming GO-480-B1A6	39	4½	31	4	208.8	2,173	3,308	15.8	159	3,280	N.A.	19,700	540	565	118	3,280	46.2
ITALY																							
Fiat																							
F-86K (North American Licence)	A.F.	Serv.	1	1×7,350-lb. Gen. Elect. J47-GE-17 (R)	37	1	42	4	288	N.A.	18,000	62.5	720	S.L.	N.A.	45,000+	N.A.	1,000	N.A.	N.A.	N.A.
G.91	F.B.	Prod.	1	1×4,850-lb. Orpheus 3	28	1	34	2½	176.7	6,250	11,365	64.3	675	5,000	N.A.	N.A.	3,280	350	N.A.	N.A.	N.A.
Macchi																							
M.B.326	T.	Prod.	2	1×1,750-lb. Viper A.S.V.8	32	11	34	5	204.5	4,678	7,174	35.1	437	20,000	2,360	36,000	2,460	745	N.A.	N.A.	190
Piaggio																							
P.149-D	T.	Serv.	2	1×270-h.p. Lycoming GO-480	36	6	28	9½	203	2,557	3,704	18.2	192	S.L.	980	19,800	1,328	680	165	10,800	52.8
JAPAN																							
Fuji																							
TIF2	T.	Dev.	2	1×4,130-lb. Orpheus B.Or. 1	34	5½	39	8½	239.2	N.A.	8,800	36.8	557	20,000	6,100	40,000	2,350	783	330	30,000	504
SPAIN																							
Casa																							
201 Alcotan	Tp.	Serv.	2+10	2×500-h.p. Sirio-VIIA	60	4	45	3	450	7,920	12,100	26.8	219	S.L.	N.A.	20,000	N.A.	621	193	6,500	N.A.
Hispano																							
HA-100-E1 Triana	T.	Prod.	2	1×755-h.p. Beta B-4	34	1	29	5	186.6	4,343	6,460	34.6	276	9,500	2,130	33,600	N.A.	821	237	9,500	132
HA-200-R1 Saeta	T.	Dev.	2	2×880-lb. Marboré IIA	34	2	29	1½	187.2	3,697	6,995	37.4	405	S.L.	3,345	39,350	N.A.	1,056	N.A.	32,800	270
SWEDEN																							
Saab																							
J29F	F.	Serv.	1	1×6,500-lb. Ghost 50 (R)	36	1	33	2½	258	10,000	14,000	54.2	658	5,000	15,000	N.A.	N.A.	1,677	N.A.	N.A.	Ext. tanks
A32A Lansen	F.B.	Serv	2	1×10,000-lb. RM5 (Avon) (R)	42	8	49	2½	402.5	15,400	22,000	N.A.	700	S.L.	N.A.	N.A.	N.A.	2,000+	N.A.	N.A.	N.A.
J35A Draken	F.	Prod.	1	1×14,500-lb. RM6 (Avon) (R)	30	10	46	7	538.2	N.A.	20,150	37.4	M=1.8	36,000	39,350	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
91-D Safir	T.	Serv.	4	1×180-h.p. Lycoming 0-360-A1A	34	9	26	0	146.3	N.A.	2,657	18.1	165	S.L.	N.A.	16,400	N.A.	620	146	3,000	38.5
SWITZERLAND																							
Pilatus																							
P-3	T.	Prod.	2	1×260-h.p. Lycoming GO-435-C2A	34	1	28	8	177	2,447	3,120	17.7	192.5	S.L.	1,380	18,040	1,120	465	157	5,000	35.2
UNITED KINGDOM																							
Armstrong Whitworth																							
A.W.660 (data apply to A.W.650)	Tp.	Prod.	3+83	4×2,100-h.p. Dart Mk. 526	115	0	86	9	1,458	20,885	82,000	56.0	N.A.	N.A.	1,400	N.A.	3,200	2,800	276	25,000	3,300
Sea Hawk FGA.6	F.B.	Serv.	1	1×5,400-lb. Nene RN.6 Mk. 103	39	0	39	8	278	N.A.	16,200	58.3	599	S.L.	5,700	N.A.	3,765	580	N.A.	N.A.	N.A.
Auster																							
AOP.9	O.	Serv.	3	1×173-h.p. Bombardier 203	36	5	23	8½	197.6	1,590	2,125	10.4	127	S.L.	970	19,500	675	242	110	1,000	15
Avro																							
Shackleton MR.3	M.R.	Serv.	10	4×2,455-h.p. Griffon 57A	119	10	92	6	1,421	N.A.	100,000	70.4	300	12,000	850	19,200	3,820	3,660	200	1,500	4,248
Vulcan B.2	B.	Prod.	5	4×17,000-lb. Olympus 201	111	0	97	1	N.A.	N.A.	180,000+	N.A.	600+	50,000	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Blackburn																							
Beverley C.1	Tp.	Serv.	4+94	4×2,850-h.p. Centaurus 173	162	0	99	5	2,916	82,100	135,000	46.4	238	5,700	760	16,000	1,340	1,063	173	12,500	N.A.
NA.39	S.	Prod.	2	2×Gyron Junior	N.A.		N.A.		N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1,400	N.A.	N.A.	N.A.
Bristol																							
Britannia C.1	Tp.	Serv.	4-7+115	4×4,445-h.p. Proteus 255	142	3½	124	3	2,075	88,250	180,000	86.7	N.A.	N.A.	N.A.	N.A.	7,200	5,310	357	23,000	8,486
Sycamore HR.14	G.P.Hel.	Serv.	1+4	1×520-h.p. Leonides 524/1	48	7*	46	2	1,856*	3,965	5,600	2.9*	127	S.L.	1,200	14,500	—	268	91	2,000	65
Type 192	G.P.Hel.	Prod.	2+18	2×1,650-h.p. Gazelle N.Ga.2	48	8*	89	9½	2×1,860*	10,481	18,000	4.84*	N.A.	N.A.	1,180	13,250	—	432	138	S.L.	560
De Havilland																							
Sea Venom FAW.22	A.F.	Serv.	2	1×5,300-lb. Ghost Mk. 105	42	10	36	8	279.8	N.A.	15,800	56.5	575	S.L.	5,900	40,000	4,230	705	—	35,000	561
Sea Vixen FAW.1	A.F.	Prod.	2	2×10,000-lb. Avon 200 Series	50	0	53	6½	N.A.	N.A.	35,000	N.A.	690	10,000	10,000+	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Vampire T.11	T.	Serv.	2	1×3,500-lb. Goblin 35	38	0	34	6½	261	—	11,150	42.7	549	20,000	4,500	40,000	2,730	850	403	40,000	—
English Electric																							
Canberra B(I).8	B.	Serv.	2	2×7,500-lb. Avon 109	63	11½	65	6	960	N.A.	45,000+	N.A.	580	40,000	N.A.	55,000	N.A.	3,000	N.A.	N.A.	Ext. tanks
Lightning F.1	A.F.	Prod.	1	2×17,250-lb. Avon R.A.24R (R)	34	10	50	0	N.A.	N.A.	N.A.	N.A.	M=2+	40,000	N.A.	60,000+	N.A.	N.A.	N.A.	N.A.	N.A.
Fairey																							
Delta 2	Ex.	Dev.	1	1×Avon 200 Series (R)	26	10	51	7½	360	N.A.	N.A.	N.A.	M=1.7+	40,000	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Gannet AEW.3	E.W.	Prod.	3	1×3,875-h.p. Double Mamba ASMD.8	54	4	44	0	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Folland																							
Gnat Mk. 1	F.	Prod.	1	1×4,520-lb. Orpheus 2	22	2	29	9	136.6	4,850	6,575	48.1	695	20,000	20,000	50,000+	2,190	920	N.A.	N.A.	332
Gloster																							
Javelin FAW.8	A.F.	Prod.	2	2×12,300-lb. Sapphire 200 Series (R)	52	0	56	9	N.A.	N.A.	32,000+	N.A.	710	10,000	12,000+	55,000	N.A.	N.A.	N.A.	N.A.	N.A.
Handley Page																							
Hastings C.2	Tp.	Serv.	5+50	4×1,675-h.p. Hercules 106	113	0	81	8	1,408	48,427	80,000	56.8	348	22,200	890	26,500	1,586	4,250	—	—	3,172
Victor B.2	B.	Prod.	5	4×17,250-lb. Conway R.Co.11	120	0	114	11	N.A.	N.A.	N.A.	N.A.	600+	50,000	N.A.	55,000+	N.A.	N.A.	N.A.	N.A.	N.A.
Hawker																							
Hunter F.6	F.	Serv.	1	1×Avon 200 Series	33	8	45	10½	349	13,500	17,800	N.A.	700+	S.L.	15,000	55,000	N.A.	550	N.A.	N.A.	410
Hunting																							
Jet Provost T.3	T.	Prod.	2	1×1,750-lb. Viper 102	36	11	32	5	213.7	4,347	7,092	33.2	329	30,000	2,380	35,000	1,990	565	273	25,000	286
Pembroke C.1	Tp.	Serv.	2+8	2×550-h.p. Leonides 127	64	6	46	0	400	9,178	13,500	33.8	224	2,000	1,070	22,000	2,520	1,150	155	8,000	232
Provost T.1	T.	Serv.	2	1×550-h.p. Leonides 126	35	2	28	8	214	3,350	4,400	20.6	200	2,300	2,200	22,500	850	650	162	5,000	66
Saunders-Roe																							
Skeeter 12	G.P.Hel.	Serv.	2	1×215-h.p. Gipsy Major 215	32	0*	26	8	805*	1,656	2,200	2.73*	104	S.L.	1,150	12,800	—	185	86	1,000	23
Scottish Aviation																							
Pioneer CC.1	G.P.	Serv.	1+4	1×540-h.p. Leonides 502/4	49	9	34	4½	390	4,230	5,800	14.9	145	1,500	1,148	15,850	800	805	115	5,000	128
Twin Pioneer CC.1	Tp.	Serv.	2+16	2×540-h.p. Leonides 514/8	76	6	45	3	670	9,502	13,500	20.1	165	1,450	970	17,000	1,272	925	117	5,000	247
Supermarine																							
Scimitar F.1	F/S	Serv.	1	2×11,250-lb. Avon 200 Series	37	2	55	4	N.A.	N.A.	40,000	N.A.	710	10,000	12,000+	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Swift FR.5	F.R.	Serv.	1	1×9,450-lb. Avon 114 (R)	32	4	42	3	306	N.A.	21,400	69.9	685	S.L.	N.A.	N.A.	N.A.	475	N.A.	N.A.	N.A.
Vickers-Armstrongs																							
Valiant B (K).1	B.	Serv.	5	4×10,000-lb. Avon 204	114	4	108	3	2,362	N.A.	160,000	N.A.	600+	40,000	5,000+	45,000+	N.A.	N.A.	N.A.	N.A.	N.A.
Westland																							
Wessex	A.S.Hel.	Prod.	5-6	1×1,450-h.p. Gazelle N.Ga.13	56	0*	56	7½	2,460*	8,350	12,600	5.13*	144	S.L.	1,650	17,000	—	340	115	S.L.	260
Whirlwind HAS.7	A.S.Hel.	Serv.	4-5	1×715-h.p. Leonides Major 755/4	53	0*	41	8	2,210*	5,375	7,800	3.53*	109	S.L.	1,200	13,200	—	334	86	S.L.	145
U.S.A.																							
Beech																							
L-23D Seminole	L.	Serv.	1+5	2×340-h.p. Lycoming G50-480-B1 B6	45	3½	31	6½	277	4,460	7,000	25.2	240	9,000	1,620	24,800	1,250	1,650	169	10,000	192
T-34B Mentor	T.	Serv.	2	1×225-h.p. Continental 0-470-13	32	10	25	11	177.6	2,254	2,985	16.75	188	S.L.	1,160	19,500	1,200	728	170	10,000	41.6
Bell																							
H-13H Sioux	G.P.Hel.	Serv.	3	1×200-h.p. Lycoming VO-435	35	1½*	31	4	965*	1,564	2,450	2.54*	100	S.L.	1,065	14,950	—	238	85	1,000	36
HU-1A Iroquois	G.P.Hel.	Prod.	1+5	1×700-h.p. Lycoming T53-L-1	44	0	53	0	1,520*	3,791	5,800	3.80*	141	S.L.	2,100	N.A.	N.A.	202	115	1,000	—
X-1E	Ex.	Dev.	1	1×12,000-lb. Reaction Motors XLR11	28	0	34	6	130	4,890	13,069	100.5	M=2.5	36,000	N.A.	N.A.	—	N.A.	N.A.	N.A.	N.A.
Boeing																							
DB-47E Stratojet	B.	Serv.	3	6×6,000-lb. Gen. Elect. J47-GE-25	116	0	109	10	N.A.	N.A.	175,000	N.A.	630	10,000	N.A.	42,000	N.A.	3,200	495	40,000	N.A.
B-52G Stratofortress	B.	Prod.	6	8×11,000-lb. P. & W. J57-P-43W	185	0	157	7	4,000	N.A.	450,000	N.A.	650	20,000	N.A.	50,000	N.A.	10,000	N.A.	N.A.‖	N.A.
KC-97G Stratofreighter	Tan/T.	Serv.	5+65	4×3,250-h.p. P. & W. R-4360-59B	141	3	110	4	1,769	82,500	153,000	86.5	375	10,000	N.A.	35,000+	N.A.	4,300	300	20,000	7,790
KC-135A Stratotanker	Tan/T.	Serv.	N.A.	4×11,800-lb. P. & W. J57-P-31	130	10	136	3	2,433	N.A.	250,000+	N.A.	642	10,000	N.A.	45,000	N.A.	N.A.	N.A.	N.A.	14,488
Cessna																							
L-19E Bird Dog	O/L.	Serv.	2	1×213-h.p. Continental O-470-11	36	0	25	10	174	1,614	2,430	13.79	115	1,000	1,150	18,500	560	530	104	5,000	34
L-27A	L.	Serv.	1+4	2×240-h.p. Continental O-470-M	35	9	27	5	175	3,146	4,830	27.6	230	S.L.	1,590	20,000	N.A.	1,250	211	8,000	111
T-37A	T.	Serv.	2	2×920-lb. Continental J69-T-9	33	10	29	3	183.9	3,890	6,403	34.82	388	35,000	N.A.	36,400	N.A.	815	308	35,000	257
Chance Vought																							
F8U-1 Crusader	F.	Serv.	1	1×16,200-lb. P. & W. J57-P-12 (R)	35	8	54	2½	N.A.	16,500	27,000	N.A.	M=1.7	36,000	15,000	54,000	N.A.	560	N.A.	N.A.	N.A.
Convair																							
B-58A Hustler	B.	Prod.	3	4×16,000-lb. Gen. Elect. J79 (R)	57	0	97	6	N.A.	N.A.	160,000	N.A.	M=2	36,000	N.A.	60,000	N.A.	N.A.	N.A.	N.A.	N.A.
C-131A Samaritan	Tp.	Serv.	3+37	2×2,500-h.p. P. & W. R-2800-99W	91	9	74	8	817	29,000	43,575	53.3	313	10,000	1,410	24,500	3,300	1,600	N.A.	N.A.	1,274
F-102A Delta Dagger	A.F.	Serv.	1	1×17,000-lb. P. & W. J57-P-35 (R)	38	1½	68	3	661.5	N.A.	27,000	N.A.	M=1.25	36,000	12,000	54,000	N.A.	N.A.	N.A.	N.A.	N.A.
F-106A Delta Dart	A.F.	Prod.	1	1×23,500-lb. P. & W. J75-P-4 (R)	38	1½	70	8½	661.5	N.A.	N.A.	N.A.	M=2	40,000	N.A.	60,000	N.A.	N.A.	N.A.	N.A.	N.A.
Douglas																							
AD-7 Skyraider	S.	Serv.	1	1×2,700-h.p. Wright R-3350-26WB	50	9	39	0	400.3	12,094	19,000	47.5	365	15,000	2,850	25,000+	N.A.	3,000	N.A.	N.A.	565

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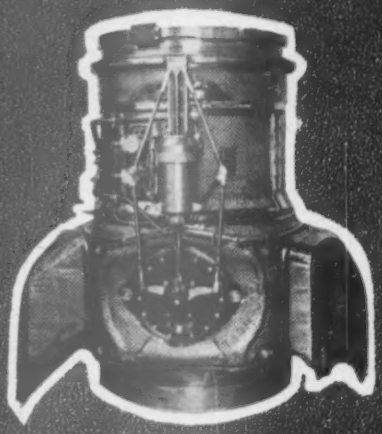
Fairchild																				
C-123B Provider	Tp.	Serv.	2+60	2×2,500-h.p. P. & W. R-2800-99W	110	0	76	3	1,223.2	31,058	56,500	49.0	245	10,000	1,150	23,000	N.A.	1,340	186	10,000	N.A.
Grumman																				
F9F-8T Cougar	F/T.	Serv.	2	1×7,250-lb. P. & W. J48-P-8A	34	6	44	5	N.A.	N.A.	*20,000*	N.A.	*700*	S.L.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
F11F-1 Tiger	F.	Serv.	1	1×11,000-lb. Wright J65-W-6 (R)	31	7½	44	6	N.A.	N.A.	13,850	N.A.	*M=1.35*	36,000	*14,000*	*55,000*	N.A.	600	N.A.	N.A.	N.A.
F11F-1F Super Tiger	F.	Dev.	1	1×15,560-lb. Gen. Elect. J79-GE-7 (R)	31	7½	48	9	249.72	N.A.	*15,000*	N.A.	*M=2.03*	*40,000*	22,960	*59,000*	*1,395u*	*525*	N.A.	N.A.	N.A.
SA-16B Albatross	Res.	Serv.	4+10	2×1,425-h.p. Wright R-1820-76A	96	6	62	4	N.A.	25,600	32,100	N.A.	277	—	—	—	—	—	230	—	—
S2F-1 Tracker	A.S.	Serv.	4	2×1,525-h.p. Wright R-1820-82	69	8	42	3	485	N.A.	21,000	43.3	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Hayes-Boeing																				
KB-50J Superfortress	Tan/T.	Serv.	N.A.	4×3,500-h.p. P. & W. R-4360-35+2×6,000-lb. J47	141	3	*105*	*0*	1,768	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Hiller																				
H-23D Raven	G.P.Hel.	Serv.	3	1×250-h.p. Lycoming VO-435-A1C	35	6*	27	9½	985*	1,780	2,700	2.74*	95	S.L.	1,050	13,200	—	205	82	1,000	40
Kaman																				
HOK-1 (and H-43A)	G.P.Hel.	Serv.	1+3–4	1×600-h.p. P. & W. R-1340-48	47	0	25	0	3,470*	4,040	5,800	1.67*	109	8,000	1,300	18,000	—	220	75	1,000	83.3
H-43B Huskie	Res.Hel.	Prod.	1+7	1×860 h.p. Lycoming T53	47	0	25	0	3,470*	4,198	7,250	2.1	132+	N.A.	N.A.	N.A.	—	264	N.A.	N.A.	160
Lockheed																				
C-130B Hercules	Tp.	Prod.	4+92	4×4,000-h.p. Allison T56-A-7A	132	7	97	8	1,745	69,300	135,000	77.3	N.A.	N.A.	2,450	35,000+	4,200	4,000	350	20,000	5,745
F-104C Starfighter	F.	Serv.	1	1×15,560-lb. Gen. Elect. J79-GE-7 (R)	21	11	54	9	179	N.A.	*17,000*	N.A.	*M=2.2*	40,000	*15,000+*	*60 000*	N.A.	N.A.	N.A.	N.A.	N.A.
P2V-7 Neptune	M.R.	Serv.	7	2×3,500-h.p. Wright R-3350-32W+2×3,400-lb. Westinghouse J34	103	10	91	8	1,000	47,450	75,500	75.5	356	10,000	N.A.	22,000	N.A.	3,700	N.A.	N.A.	1,832
T-33A	T.	Serv.	2	1×5,200-lb. Allison J33-A-35	38	10½	37	9	237	8,400	11,965	50.5	540	S.L.	4,680	47,500	2,560	1,345	N.A.	N.A.	Ext. tanks
T2V-1 Seastar	T.	Serv.	2	1×6,100-lb. Allison J33-A-22	42	10	38	6½	N.A.	11,500	15,500	N.A.	580	35,000	5,400	40,000	N.A.	900	N.A.	N.A.	633
WV-2 (and RC-121C)	E.W.	Serv.	31	4×3,500-h.p. Wright R-3350-34	123	0	116	2	1,650	N.A.	140,000	84.8	*305*	20,000	N.A.	N.A.	N.A.	*245*	N.A.	N.A.	5,454
McDonnell																				
F-101C Voodoo	F.	Serv.	1	2×14,500-lb. P. & W. J57-P-13 (R)	39	8½	67	4½	N.A.	*28,000*	*40,000*	N.A.	M=1.85	40,000	*14,000*	*52,000*	N.A.	*3,000*	*595*	*36,000*	Ext. tanks
F3H-2N Demon	A.F.	Serv.	1	1×14,250-lb. Allison J71-A-2 (R)	35	4	58	4	*500*	N.A.	*30,000*	N.A.	*730*	S.L.	*12,000*	N.A.	N.A.	*1,500*	N.A.	N.A.	N.A.
F4H-1	A.F.	Dev.	2	2×16,000-lb. Gen. Elect. J79 (R)	38	5	56	0	N.A.	N.A.	40,000+	N.A.	*M=2*	40,000	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Martin																				
B-57B	B.	Serv.	2	2×7,220-lb. Wright J65-W-5	64	0	65	6	960	*30,000*	*49,500*	N.A.	620	35,000	N.A.	48,000	N.A.	2,300	N.A.	N.A.	N.A.
PSM-2 Marlin	M.R.	Serv.	7	2×3,400-h.p. Wright R-3350-32W	118	2½	101	9½	1,406.3	49,480	74,442	52.9	245	S.L.	N.A.	22,400	N.A.	2,050	N.A.	N.A.	2,339
North American																				
A3J-1 Vigilante	B.	Prod.	2	2×15,000-lb. Gen. Elect. J79-GE-2 (R)	50	0	70	0	N.A.	N.A.	*49,500*	N.A.	*M=2+*	40,000	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
F-100C Super Sabre	F.B.	Serv.	1	1×16,000-lb. P. & W. J57-P-21 (R)	38	0	47	0	N.A.	N.A.	*28,000*	N.A.	*M=1.2*	35,000	N.A.	50,000+	*4,500u*	1,150	N.A.	N.A.	1,450
F-107A	Ex.	Dev.	1	1×P. & W. J75 (R)	36	7	60	10	N.A.	N.A.	N.A.	N.A.	*M=2+*	40,000	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
FJ-4B Fury	F.B.	Serv.	1	1×7,700-lb. Wright J65-W-16A	39	1	37	6	N.A.	N.A.	26,000	N.A.	715	S.L.	8,000	45,000+	N.A.	N.A.	N.A.	N.A.	N.A.
T-28B	T.	Serv.	2	1×1,425-h.p. Wright R-1820	40	7	32	9	268	6,424	8,004	29.0	346	S.L.	3,830	37,000	1,140	1,060	250	10,000	104
T2J-1	T.	Prod.	2	1×3,400-lb. Westinghouse J34-WE-36	36	0	38	4	255	N.A.	9,507	37.3	494	25,000	*5,000*	41,000	*2,010*	967	422	40,000	484
X-15	Ex.	Dev.	1	1×50,000-lb. Reaction Motors XLR-99	22	0	50	0	200	N.A.	31,276	156.4	*3,600*	N.A.	N.A.	*530,000*	—	N.A.	N.A.	N.A.	N.A.
Northrop																				
F-89H Scorpion	A.F.	Serv.	2	2×7,200-lb. Allison J35-A-35 (R)	59	8	53	10	562	N.A.	*41,000*	N.A.	*630*	S.L.	N.A.	51,000	N.A.	1,700	N.A.	N.A.	N.A.
T-38 Talon	T.	Prod.	2	2×*3,700-lb.* Gen. Elect. J85 (R)	25	3	42	8	170	N.A.	10,960	64.5	*M=1.28*	35,000	N.A.	*55,000*	N.A.	*1,200*	N.A.	N.A.	N.A.
Republic																				
F-84F Thunderstreak	F.B.	Serv.	1	1×7,200-lb. Wright J65-W-3	33	7½	43	4½	N.A.	N.A.	26,030	N.A.	720	S.L.	7,500	48,000	N.A.	1,700	N.A.	N.A.	Ext. tanks
F-105B Thunderchief	F.B.	Serv.	1	1×23,500-lb. P. & W. J75-P-5 (R)	34	11	63	1	N.A.	N.A.	*40,000*	N.A.	*M=2+*	35,000	N.A.	*50,000*	N.A.	2,000+	N.A.	N.A.	Ext. tanks
Sikorsky																				
H-37A (and HR2S-1) Mojave	Tp.Hel.	Serv.	3+23	2×1,725-h.p. P. & W. R-2800-50	72	0*	82	10	4,070*	20,690	30,188	7.42*	130	S.L.	990	8,700	—	138	115	1,000	250
H-34A Choctaw (and HSS-1, HUS-1)	G.P.Hel.	Serv.	2+14	1×1,525-h.p. Wright R-1820-84	56	0*	47	2	2,460*	7,646	11,867	4.82*	134	S.L.	1,500	12,000	—	225	101	1,000	165
Temco																				
TT-1 Pinto	T.	Serv.	2	1×920-lb. Continental YJ69-T-9	29	10	30	7	150	3,139	4,400	29.3	345	15,000	1,900	32,200	2,995	405	270	25,000	103
Vertol																				
HUP-2 Retriever (and H-25A)	G.P.Hel.	Serv.	2+4	1×550-h.p. Continental R-975-46	35	0*	32	0	2×960*	4,132	5,750	3.0*	105+	S.L.	1,000	10,000+	—	340	80+	1,000	N.A.
H-21B Shawnee	G.P.Hel.	Serv.	2+20	1×1,425-h.p. Wright R-1820-103	44	0*	52	6	2×1,520*	8,800	13,500	4.44*	127	S.L.	1,050	N.A.	—	280	101	1,000	250
U.S.S.R.																				
Ilyushin																				
Il-28 ("Beagle")	B.	Serv.	4	2×5,955-lb. VK-1	68	0	62	0	N.A.	*26,000*	*38,000*	N.A.	580	S.L.	2,950	41,000	N.A.	1,600	450	35,000	2,620
Mikoyan/Gurevich																				
MiG-15*bis* ("Fagot")	F.	Serv.	1	1×5,955-lb. VK-1	33	1½	36	4	255	8,320	11,085	43.5	*700*	S.L.	10,400	49,000+	N.A.	N.A.	N.A.	N.A.	N.A.
MiG-17 ("Fresco-C")	F.	Serv.	1	1×7,590-lb. VK-1A (R)	*36*	*0*	*38*	*0*	265	9,850	13,200	50.0	640	S.L.	10,500	57,100	N.A.	1,160	N.A.	N.A.	539
MiG-19 ("Farmer")	F.	Serv.	1	2×8,820-lb. VK-5 (?)	32	0	37	6	N.A.	N.A.	19,840	N.A.	M=1.4	10,000	*15,000*	*58,000*	N.A.	600	N.A.	N.A.	N.A.
MiG-21 ("Faceplate")	F.	Serv. (?)	1	1×*18,000-lb.* turbojet (R)	27	0	46	*0*	*250*	*12,000*	*20,000+*	N.A.	*M=1.5–2.0*	30,000	*15,000*	*60,000*	N.A.	*350*	N.A.	N.A.	N.A.
Mil																				
Mi-1 ("Hare")	G.P.Hel.	Serv.	1+3	1×575-h.p. AI-26V	45	11*	39	8	1,650*	3,925	4,960	3.01*	115	S.L.	1,280	N.A.	—	240	60	1,000	N.A.
Mi-4 ("Hound")	G.P.Hel.	Serv.	2+14	1×1,700-h.p. ASh-82V	68	11*	53	5	3,710*	N.A.	15,952	4.28*	150	5,000	N.A.	16,000	—	250	99	1,000	N.A.
Myasishchev																				
("Bison")	B.	Serv.	*8*	4×*19,180-lb. AM-3M*	*170*	*7*	*162*	*5*	*3,660*	N.A.	*352,750*	N.A.	*559*	40,000	N.A.	*40 000*	N.A.	6,000	N.A.	N.A.	N.A.
Sukhoi																				
("Fishpot")	F.	Serv. (?)	1	1×*22,000-lb.* turbojet	*25*	*0*	*50*	*0*	*260*	N.A.	N.A.	N.A.	*M=2.0+*	40,000	*15,000+*	60,000	N.A.	400	N.A.	N.A.	N.A.
Tupolev																				
Tu-14 ("Bosun")	B.	Serv.	4	2×5,955-lb. VK-1	*70*	*0*	65	*0*	N.A.	N.A.	*45,000*	N.A.	*560*	10,000	N.A.	48,000	N.A.	*1,800*	N.A.	N.A.	N.A.
Tu-16 ("Badger")	B.	Serv.	5–6	2×*19,180-lb. AM-3M*	111	6	118	0	2,002	N.A.	*175,000*	N.A.	620	10,000	N.A.	45,000	N.A.	*3,500*	*480*	*40,000*	*10,000*
Tu-20 (?) ("Bear")	B.	Serv.	*8*	4×12,000-h.p. NK-012M	*177*	*2*	*155*	*0*	*2,800*	N.A.	*340,000*	N.A.	*620*	*10,000*	N.A.	*34,000*	N.A.	*6,250*	*560*	*36,000*	N.A.
Yakovlev																				
Yak-11 ("Moose")	T.	Serv.	2	1×730-h.p. ASh-21	30	10	27	10½	166	4,410	5,512	33.2	286	7,380	1,770	23,300	*1,640u*	795	205	5,600	79
Yak-12M ("Creek")	L.	Serv.	4	1×240-h.p. AI-14R	41	4	29	6	256.8	2,262	3,197	12.4	112	S.L.	805	13,650	N.A.	280	79	N.A.	N.A.
Yak-18 ("Max")	T.	Serv.	2	1×160-h.p. M-11FR	33	9½	26	6	183	1,795	2,470	13.5	153	S.L.	N.A.	13,120	*950u*	620	133.5	N.A.	28.5
Yak-24 ("Horse")	G.P.Hel.	Serv.	3+40	2×1,700-h.p. ASh-82V	68	11*	92	*0*	2×3,710*	N.A.	*35,200*	4.75*	N.A.	N.A.	N.A.	*18,000*	N.A.	*500*	*110*	1,000	N.A.
Yak-25 ("Flashlight A")	A.F.	Serv.	2	2×*8,000-lb.* turbojets	*40*	*8*	*54*	7½	*320*	*17,000*	*23,000*	N.A.	*683*	10,000	N.A.	*50,000*	N.A.	1,600	N.A.	N.A.	N.A.
("Backfin")	B.	?	—	2×turbojets	*78*	*0*	*102*	*0*	N.A.	N.A.	N.A.	N.A.	*M=1.5*	30,000	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
("Blowlamp")	B.	?	3–4	2×16,500-lb. MR-40 (R)	65	7	75	5	856	*30,000*	*50,000*	N.A.	*M=1.3*	30,000	N.A.	*50,000*	*3,000u*	*1,000*	N.A.	N.A.	N.A.

Abbreviations.—A.F., all-weather fighter; A.S., anti-submarine; B, bomber; E.W., early-warning aircraft; Ex., experimental or research aircraft; F., fighter; F.B., fighter-bomber; F.R., fighter-reconnaissance; G.P., general purpose; Hel., helicopter; L., liaison; M.R., maritime reconnaissance; O., observation; Res., rescue; S., strike; T., trainer; Tan/T., tanker-transport; Tp., transport; Dev., under development; Prod., in production, not yet in service; Serv., in service; (R), thrust quoted with re-heat; *u*, distance to unstick; * helicopter rotor diameter, disc area and disc loading respectively. DATA IN ITALICS ARE ESTIMATED OR APPROXIMATE.

Successful heat exchange and heat insulation



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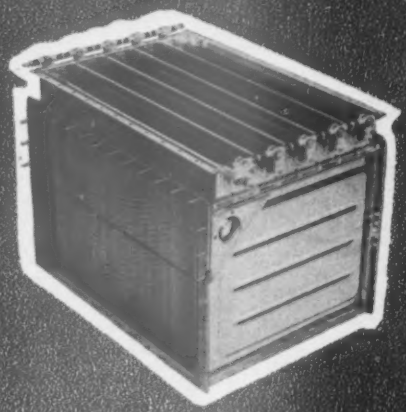

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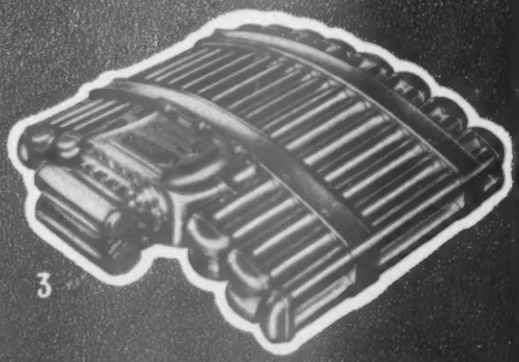

3

Success in our business doesn't merely mean the ability to manufacture, though we are extremely well equipped, even to the extent of having our own aluminium flux bath brazing plant.

Success to us, means the ability to solve problems ; to produce something that will do a new job, or perhaps an old job in never-before-experienced circumstances. And then, of course, to make it a practical and economical proposition.

We have forty years experience and wide resources. If we can help you in any way with heat exchange and insulation equipment, please contact us. We are always at your service.

1 *These thermal blankets are made of refractory fibre cased in .004 inch (.1016 mm) stainless steel. They are made-to-measure and are extremely light, the dimpled construction being responsible for their great strength. Specified for Rolls-Royce and Armstrong Siddeley jet and turbo-prop engines, these particular examples are shown fitted to the Rolls-Royce thrust reverser for the de Havilland Comet.*

2 *We design, manufacture and supply heat exchangers for many purposes in both aluminium alloy and stainless steel. This particular example is for the Vickers Vanguard's anti-icing system. Similar units are being supplied for the Fokker Friendship, the Bristol Britannia, the Armstrong Whitworth Argosy, the Vickers Viscount and the Handley Page Herald.*

3 *High pressure fuel-cooled oil cooler for high performance gas turbine engines. This unit is used in the Armstrong Siddeley Sapphire S.A.7.*

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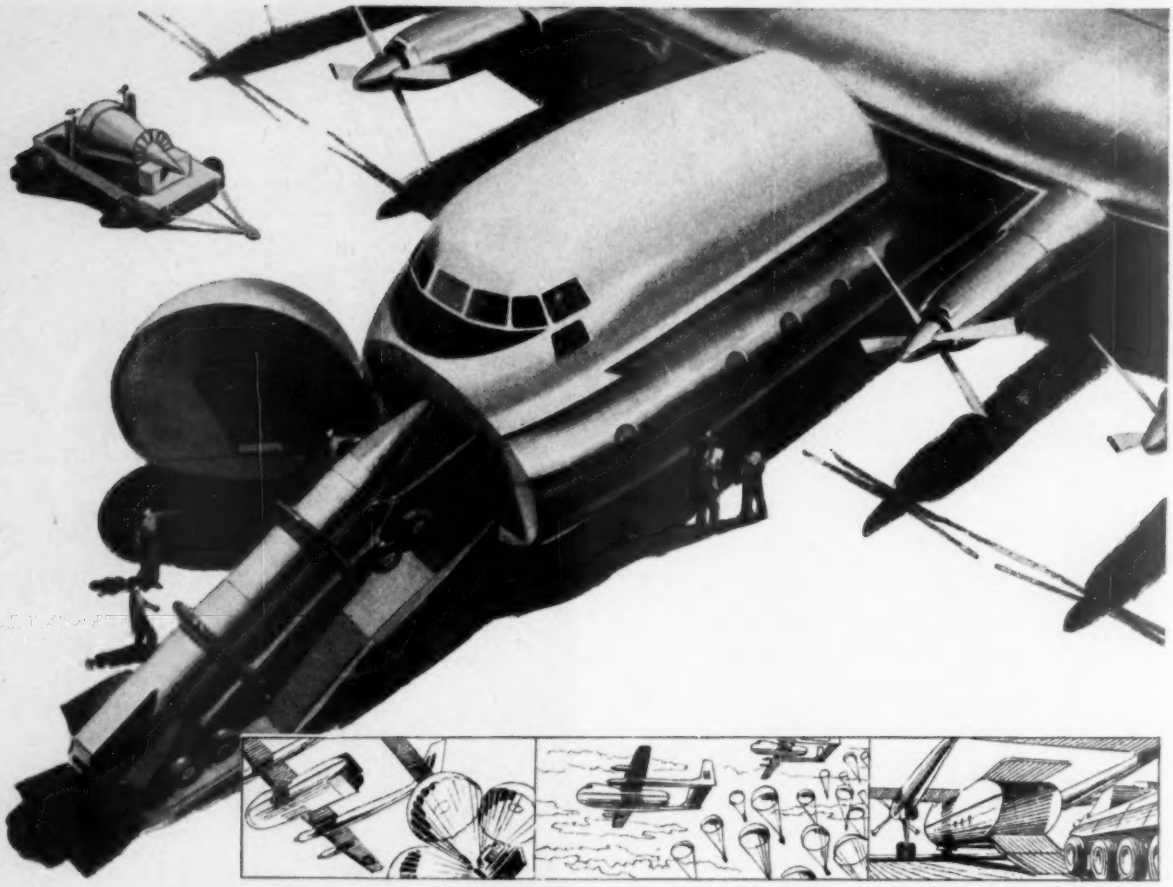
We have now introduced Sealed Thermal Insulation Blankets for Civil Aircraft



A.W.660 –

New kind of Transport for the New kind of Army

ADOPTED BY R.A.F. TRANSPORT COMMAND

As weapons grow more complicated and bulkier, as the pace of military action increases, the need for such a transport as the AW.660 becomes vital. Powered by four Rolls-Royce Dart engines, the AW.660 is a medium-range aircraft, cruising at 300 m.p.h. It can carry over 13½ short tons of the most bulky equipment needed by a modern fighting force. The wide, fully-pressurised fuselage will take armed troops, radar equipment, guided weapons, wheeled vehicles and all the necessary stores of a mobile military unit. The Beaver Tail rear doors may be opened in flight for supply-dropping by parachute. On the ground the bottom half of the Beaver Tail is lowered to form an integral loading ramp. The AW.660 can readily be operated from makeshift airfields.

The AW.660 provides mass transport in the minimum of time. It can play a vital role in a world whose freedom may depend on high mobility of forces and equipment.

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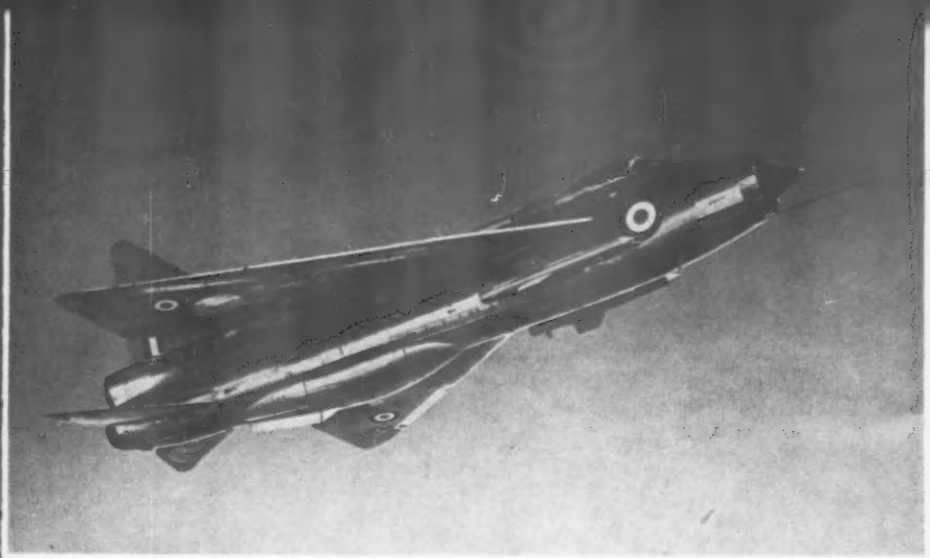

MANNED INTERCEPTOR.—Armed with two Firestreak air-to-air guided missiles, the English Electric Lightning is a formidable weapon scheduled to enter operational service with Fighter Command in the near future.

Military Aircraft . . . .

(*Continued from page 334*)

Last, but by no means least, of the methods of improving bomber operational effectiveness is the development and expansion of the use of airborne electronic counter-measures. Employed for both anti-detection and for vastly increasing the task of intercepting a bomber force, these measures generally reduce the efficiency of the defence organization by interfering with air and ground radars and communication networks.

Another major factor which has contributed to effectiveness of Bomber Command is the development in the field of reconnaissance. The main change and improvement in the art is the introduction of radar mapping which involves the photographing of the aircraft's cathode-ray tube (C.R.T.) presentation. Equally effective by day or night, radar reconnaissance is unaffected by cloud except for heavy cumulo-nimbus which shows up on the C.R.T. and has a shadow area behind it from which there are no radar reflections.

Recent improvements in definition in radar pictures and faster films and camera lenses have enabled radar-scope photographs to be taken which can be electronically analysed using density-cutting techniques. This method of reconnaissance is still being developed and suffers from processing and interpretation delays, although developments will steadily eliminate these. On the credit side variation of scale with distance from the aircraft can be corrected electronically.

Finally, to ensure that we have an effective deterrent plans must be made to operate in all weather conditions.

At present the only way we can achieve all-weather operations is by use of the automatic landing system. Such a system as developed by the Blind Landing Experimental Unit accepts an aircraft on automatic approach at a height of about 250 ft., then brings the aircraft down to the final part of the approach path, keeping it on the centre-line of the runway and maintaining the selected approach speed. At the appropriate height the "flare out" is initiated, the throttles closed and drift taken off. Directional control along the runway is maintained until the flying controls lose their effectiveness, the pilot then disengages the auto-pilot and stops the aircraft by braking, keeping it on the centre-line of the runway by using the guidance information presented to him.

The V-bombers will have this equipment installed.

Unmanned Weapons

Complementary to the V-bombers is the ballistic missile, Blue Streak, which is being developed in this country. This has a range of 2,000 to 2,500 miles and is classified as a medium-range weapon with a far greater operational flexibility than the American Thor IRBM.

Stored and launched from underground, Blue Streak will have a thermo-nuclear warhead and its rocket motor is reported to be based on one developed by the Rocketdyne division of North American Aviation. In parallel with this work on Blue Streak is the development of the re-entry research vehicle, Black Knight, which will probably be used to test the nose cone of the ballistic missile.

These two weapons, the manned bomber using the stand-off bomb and the ballistic missile, will together be combined to provide Bomber Command with a means of attacking an enemy so as to present him with an extremely difficult defence task. When defences have been developed against these weapons, a second generation of manned and unmanned weapons will be required to maintain the potential of our deterrent force.

As announced in the memorandum published with this year's Air Estimates, Bomber Command Valiants are being assigned to the NATO Command for use in the tactical rôle. The Command's Canberra B.6s which they are replacing will be redeployed in the Middle East to replace the Canberra B.2s in service with M.E.A.F. The Valiants, which will remain based in the U.K. and be equipped with nuclear weapons, will give the European Command a bomber with a far greater range than before, which can meet the requirements more effectively than the Canberra, particularly at night.

To be without a high-performance tactical aircraft for the reconnaissance, bomber and fighter rôles is considered to be fatal and the recent order of the TSR-2 to replace the Canberra is a logical step. This general-purpose aircraft designed to meet the requirements given at the start of this paragraph will be able to carry both nuclear and conventional bombs and has a performance which gives it the possibility of use in the tactical air battle equipped with air-to-air missiles.

Originally based on the General Operational Requirement No. 339, the present Operational Requirement for the TSR-2 incorporates a number of technical developments which will greatly increase the usefulness of the aircraft in limited operations and for close support of the Army, particularly by reducing the length and strength of runways required for take-off. While the TSR-2 is capable of performing the rôles of the various marks of Canberra it will, by reason of its greater flexibility and better performance, be far more versatile

ALL-WEATHER FIGHTER.—Gloster Javelins are already fully operational with the R.A.F.—the latest version, carrying four Firestreaks, is the Javelin Mk.8 and will come into service during 1959/60.

Military Aircraft . . . .

and a better general-purpose tactical aircraft. It will, for example, be given an advanced reconnaissance capability.

For the more limited ground support rôles, such as overseas policing requirements and other similar needs, the R.A.F. has always employed well-tried U.K. fighters, and to find a replacement for the Venom in the Middle and Far East the Service held a series of trials last year in Aden. From these it was found that the Hunter, stocks of which already exist and will increase as they are replaced in service by the Lightning, was most suitable for the job. The Gnat was superior in some respects but on balance was slightly inferior in its present form. The fact that Hunters exist and no new purchase was involved was a strong point in favour of the Hunter.

All the evidence of recent years points to the continuing need for an aircraft of this type. Aircraft to meet global or limited war conditions are becoming steadily more complex, costly and exacting. It may therefore be necessary to develop types specifically to meet the overseas police or cold war requirements efficiently and at least cost.

So long as the threat of manned bombers and reconnaissance aircraft remains, the fighter will be required in the U.K. air defence system which is regarded as an essential part of our deterrent force. As opposed to the surface-to-air missile the fighter is the only weapon which can be used to investigate unidentified aircraft, at present deal with the stand-off bomber, the electronic-jamming aircraft and the radar reconnaissance aircraft operating at relatively long ranges from its target.

To improve the effectiveness of Fighter Command in its defence task its various marks of Javelin at present in service are to be replaced with Mk. 8s during 1959-60, and finally the Lightning P.1B will supersede both the Javelin FAW.8 and the Hunter 6. Javelin FAW.7s already in service, are to be modified with the Mk. 8 reheat installation. The Mk. 8 and the P.1B are to be fitted with Firestreak AAMs. The P.1B will later be equipped with a more advanced weapon capable of intercepting the higher performance bombers.

Last year it was officially announced that we would not develop another fighter after the P.1B, which is due in squadron service next year. But if we are to keep pace with the increasing threat, particularly the longer range stand-off bomb, the idea of a long-range defence system which could include another fighter equipped with AI and AAMs of an advanced type must be kept in mind. This aircraft must be capable of intercepting and destroying an attacker well beyond the practical range of SAMs.

Planned to come into full service in 1961, the first of the R.A.F.'s surface-to-air missiles, the Bristol Ferranti Bloodhound, will add to the effectiveness of the present all-fighter defence force. A semi-active homing weapons system for operation from fixed bases, Bloodhound is estimated to have a range of approximately 50 miles and an operational ceiling of the order of 60,000 ft. Thought to have a supersonic flight speed of about M=2.5, the weapon is now being deployed in an operational rôle.

Clearly a successor to this first generation of surface-to-air missiles will be required. A development of Bloodhound would be attractive to the R.A.F. but a developed Thunderbird from English Electric with its solid propellent equally has possibilities.

UNMANNED INTERCEPTOR.—Bristol Ferranti Bloodhound surface-to-air anti-aircraft guided weapons are scheduled to be in full service with the R.A.F. in 1961.

Transports and Air Mobility

It has been officially stated that Transport Command's carrying capacity will increase nearly threefold between 1955 and 1960. From a graph prepared by the Air Ministry this is shown to be approximately 55 million passenger-nautical miles per month at the end of 1955 rising to 75 million in 1957 and a little under 100 million at the start of this year. By 1960 it is expected to reach a little under 150 million. These figures are based on the capacity of each type of aircraft over the range appropriate to its rôle and assume normal utilization rates; in an emergency it is stated these might be almost double.

Although these figures show that the operational effectiveness of Transport Command has grown rapidly in the past four years and will increase at a faster rate during the next 12 months, they cannot conceal the fact that the Service does not possess a very large high-speed strategic transport potential. If the rapid deployment of our Strategic Reserve is to take place for the reinforcement of the overseas theatres of operation, or U.K.-based detachments of fighters and bombers are to be

(*Continued on page 343*)

TACTICAL FREIGHTER.—A military version of the Armstrong Whitworth 650 Argosy transport is on order for Transport Command.

de Havilland serves the Royal Navy

The de Havilland (D.H. 110) Sea Vixen, fitted with de Havilland "Firestreak" infra-red guided weapons, provides the senior service with a transonic all-weather day and night fighter of very high performance for carrier and shore-based operations. Its ability to carry a heavy load over a wide radius makes the Sea Vixen ideally suitable for the strike-reconnaissance role.

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Military Aircraft . . . .

(*Continued from page 342*)

supported by large numbers of ground personnel and their equipment, a fleet of large-capacity turboprop and pure jet transports are necessary.

This requirement will be partly met by the 20 Britannias which are scheduled to start coming into service later this year, by the Comet 2s of No. 216 Squadron and by the Britannic 3s which have recently been ordered. But this complete force of transports will not be available for some years —1962 at the earliest—and then the lack of a high-speed jet freighter will still be present. This emphasizes the tragedy of the cancellation of the Vickers V.1000.

Initiated in 1951 to meet an Air Staff requirement for a jet transport, the design of the V.1000 made much use of experience gained with the Valiant, although it was much larger—comparative spans were 140 ft. and 114 ft. Fitted with a hydraulic freight lift in the rear fuselage and providing accommodation for 120 equipped troops it had a gross weight of 248,000 lb. and a payload of 30,000 lb. Its estimated performance at 40,000 ft. gave it a cruising speed of 450 knots, TAS, and a still-air range of approximately 4,800 nautical miles. It is interesting to compare these performance figures with those of the H.P.III and Britannic 3.

The reasons for the cancellation of the V.1000 were officially stated to be, first, that the aircraft could not meet the full specification in time; secondly, that it might have met this specification, but several years later than anticipated; and thirdly, that the Britannia, though not meeting this particular specification, could be available earlier. As it is, the first Britannia is now only undergoing its clearance trials.

With the present orders for military transports and the estimated service life of a further five years for the Comet 2s at today's utilization rate, the Service will be without a jet transport by 1965. There is no replacement for the Comet 2 in sight at present and it would seem to the outside observer that a jet transport such as the H.P.III would meet the Service's requirements in the strategic transport field better than the Britannic 3, especially with its considerably higher operating speeds. In the Government's view, the Britannic 3 has the required range, capacity and runway performance needed, coupled with a lower capital cost than that of a pure jet transport of corresponding capacity, giving it civil possibilities.

The H.P.III project, developed from the Victor, had a design speed of 545 m.p.h. for long-range operation combined with the tactical ability to land on 1,000-yd. strips. Operating at an all-up weight of 240,000 lb. it was to carry a 53,000-lb. payload over a still-air range of 3,300 nautical miles. In the tactical rôle, with a maximum take-off weight from short strips of 180,000 lb., it can be used in various ways for troop transportation, freighter or paratroop or supply-dropping.

Based on the Britannia, the Britannic 3 on the other hand has a design all-up weight of 195,000 lb., its maximum payload is 75,000 lb. which can be carried for a still-air range of 1,400 miles at a speed of 360 m.p.h. With a 30,000-lb. payload its range is 4,600 nautical miles. For tactical operations it can carry a 33,000-lb. payload to a 1,000-yd. strip 860 miles from base and return with a payload of 30,000 lb. In the trooping rôle, 140 troops can be accommodated on the main hold floor and approximately 60 more on a removable second floor at the forward end of the fuselage.

In the tactical field and Army close support transport rôle the R.A.F. requirement is for a freighter with a relatively short range when carrying a full payload, which also has a good ferry range when empty. It must also drop paratroops, platforms and supplies. With heavy equipment designed to be broken down into small packages for air transportation then the rôle can be filled by a relatively small freighter which will mean that the Service will be able to have a large number, giving better flexibility.

To meet this requirement put forward originally in 1953, the A.W.660, a military version of the Armstrong Whitworth A.W.650 Argosy which first flew at the beginning of January, has been ordered. Fitted with a beaver tail rear end door with integral loading ramp and provision for supply dropping, the Argosy has a gross weight of 82,000 lb. Its maximum no-reserves payload is 28,000 lb. for a range of 600 nautical miles or 20,000 lb. for a range of 1,400 nautical miles. With full tanks (3,300 Imp. gal.) the Argosy has a maximum still-air range of 2,480 nautical miles, which presumably could be increased with removable fuselage tanks for ferrying in the military A.W.660 version.

To help fill the need for short-range tactical transports until the A.W.660 comes into operational service, Hastings are to be transferred to this rôle to supplement the Valettas and Beverleys as they are replaced in the long-range strategic field by Britannias. Also, for shorter-range Army close support work there is the Twin Pioneer.

Operational development of the R.A.F.'s helicopter potential, for use in the rapid movement of troops to their tactical operational positions, is also under way. The Bristol 192 general purpose helicopter has been ordered and the Whirlwind is to be re-engined with a turbine powerplant. The Sycamore will not be developed any further and will go out of service.

There is also a need for vertical take-off medium capacity tactical transports, although the number of types in service must be kept to a minimum. For this requirement such an aircraft as the Fairey Rotodyne might well fill the bill. Such a limited transport force must be centralized and worked to its full capacity.—P.R.R.

VTOL TRANSPORTS.—Both the Bristol Type 192 helicopter and the Fairey Rotodyne offer considerable promise for certain Service transport rôles. The 192 has been already ordered as a general-purpose type.

Military Aircraft . . . .

Poised above the caldrons
of the storm,
Their hearts, contemptuous
of death, shall dare
His roads, between the thunder
and the sun

George Sterling

Photographs by Paul Cullerne

This first production Avro Vulcan B.2 flew in August of last year. Powered by four 17,000 lb.s.t. Bristol Olympus 201 turbojets, the B.2 has greater wing span and area than the earlier version coupled with an increase in its gross all-up weight. Other changes include a reduced wing thickness-chord ratio, the replacement of the former separate aileron and elevator control surfaces on the wing trailing edges by elevons and the incorporation of conical camber along the cranked leading edges. Above all, the Vulcan B.2 is capable of carrying the stand-off bomb, which is being developed by the same manufacturer.

Military Aircraft . . . .

Britain's Fleet Air Arm Today and Tomorrow

THE strength and hitting power of the Royal Navy of today lies in its aircraft carriers and the aircraft which they carry. The rôles which they fulfil are all-embracing and cover every aspect of naval warfare.

Carriers, of which there are some four in commission today, have to provide the hangar space for these aircraft. They have to provide facilities for maintenance and testing of the aircraft and their equipment; accommodation and feeding arrangements for the men involved in these tasks; the capability of launching and recovering the aircraft, involving catapults and arrester gear; and, finally, the capability of controlling and operating the aircraft while they are airborne, together with aids to enable the aircraft to find their way back to the ship after a mission.

This means the carrier has to be able to combine the functions of an airfield, a GCI station and a radar report station, as well as offer homing and GCA facilities. The complexity of this installation is understandable, especially as it has to be crowded into the hull of one ship and has to be able to operate in all weathers for long periods with the ship liable to be moving appreciably in heavy seas.

The great value of the carrier is its mobility; its ability to transport from one theatre of war to another this complex installation; its ability to operate in places where shore-based air facilities are not available. It is these very qualites of mobility and flexibility which enable the Carrier Task Force to hold a unique position in the United Kingdom Defence system, for it can make a major, and perhaps decisive, contribution in cold, limited and global war alike. No political pressure, no denial of overflying rights, no military occupation or revolutionary coup can deny us the use of this ever-ready airfield or prevent its rapid deployment through the free areas of the World, to show its strength in troubled areas, independent of base facilities for long periods.

In the nuclear concept of war, the carrier is less vulnerable than any shore-based air installation. Its position is never static, no ICBM launcher can be "focused" at all times on it. The carrier has to be located, fixed and struck, but at all times it has its own strong defences against attack. These include fighter defence against the shadowing aircraft; fighter defence and supporting guided-missile ships against striking aircraft; anti-submarine defence; and its own overall mobility which necessitates its constant relocation.

At this point it is useful to take these various rôles individually and discuss how the aircraft carry out their tasks.

In the first instance, what is required in the anti-submarine rôle? From time immemorial, the Royal Navy has been required to keep the sea lanes open so that the food and supplies required to maintain life in the U.K., or to support our Armed Forces overseas, can safely cross the seas. The convoys must be protected from submarine attack.

In addition, other naval forces operating, say, in support of a land battle, or in defence of our own shipping against attack by enemy surface craft, must also be protected from the underwater threat. This threat exists in both the global and the limited war with submarine forces being made available to crush the smaller nations.

This is a fundamental issue of pure survival, which the nuclear submarine and torpedo has merely emphasized. Our anti-submarine forces are few in number; yet the threat, if major war should come, is such as to make that of 1939 fade into insignificance. Neither ships nor aircraft alone can help to defeat the vast fleet of modern submarines by which we may be opposed and only the most expert co-operation between surface escorts, aircraft and anti-submarine submarines can hope to win the next Battle of the Atlantic, should it come. Happily, such teamwork exists within the British and NATO forces, and is daily developing in skill and efficiency with every exercise.

The Fleet Air Arm contribution to this anti-submarine team is based mainly on the use of helicopters. The aircraft operating from a carrier hovers over the sea with a sonar ball suspended by a wire from its belly. The sonar ball locates the submarine in the same way as does the surface vessel and the attack is made with airborne torpedoes.

A great advantage of the helicopter over the surface vessel in this respect is its ability to keep the sonar ball stationary while it is working. By this means the noise caused by the flow of water past the ship's sonar, which is experienced with surface vessels, is avoided.

The helicopter being used at present is the Westland Whirlwind HAS.7, which carries a crew of three; this type is being replaced in the early 1960s by the turbine-powered Wessex.

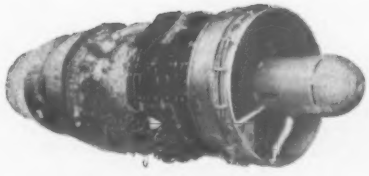
(*Continued on page 347*)

NEW SERVICE TYPES.—Top left, the Fairey Gannet AEW.3 which is soon to replace the Douglas AD-4W Skyraider in early warning radar duties, left, the Fleet's new anti-submarine helicopter the Westland Wessex. Above, the Blackburn NA.39 all-weather low-level carrier strike aircraft.

FOR ALL TYPES OF MILITARY AIRCRAFT

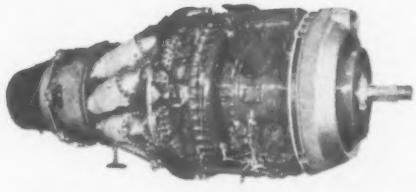
ROLLS-ROYCE

GAS TURBINES



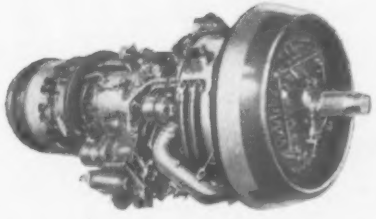
AVON

Avon engines of up to 11,250 lb. thrust are in production for subsonic and supersonic aircraft and are being developed to deliver considerably higher powers with and without re-heat. These new engines will incorporate the accumulated experience of 2,000,000 hours of Avon operation with the armed forces of eleven countries. Avon engines are installed in Fighters, Bombers and Transports including the Commonwealth Sabre, the de Havilland Comet 2 and Sea Vixen, the English Electric Canberra and Lightning, the Hawker Hunter, the SAAB Lansen and Draken, the Vickers Valiant and the Vickers Supermarine Scimitar. Avon engines are also built under licence in Australia, Belgium and Sweden.



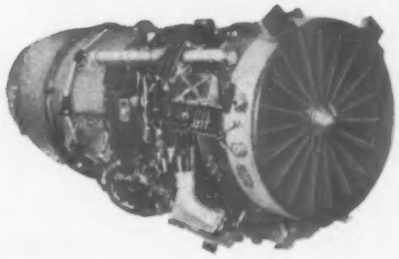
DART

The Dart prop-jet is in service or under development at powers from 1,540 e.h.p. to 3,200 h.p. It is the most proven prop-jet in the world, having already flown over 6,000,000 hours in airline operation at overhaul lives of up to 2,300 hours. Extensively used in civil aviation, it is also on order for the Breguet Alize anti-submarine aircraft and the military version of the Armstrong Whitworth Argosy.



TYNE

The Tyne is an advanced twin-spool high compression prop-jet designed to give a very low fuel consumption and due to enter service in 1960 at ratings of 4,985, 5,525 and 5,730 e.h.p. It has been chosen to power the Canadair CL.44D long range transport for the Royal Canadian Air Force and the Short Britannic 3 transport for the Royal Air Force.



CONWAY

The by-pass principle, proved by Rolls-Royce in the Conway by-pass turbo jet, is now accepted as the correct formula for all jet transport and for certain other military applications. The Conway powers the Handley Page Victor B.Mk.2 on order for the Royal Air Force.

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The ENGLISH ELECTRIC Lightning is one of the most advanced fighters in the world. Even so the basic design has further great potential development—not only in performance, but also in adaptation to other operational roles. This built-in stretch offers economies of production and operation as well as ensuring that, tactically speaking, it can be adapted to meet any situation which may arise.

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ALL-WEATHER PROTECTION.—The D.H. Sea Vixen FAW.1 which is due in service this year and will replace the Sea Venom in the all-weather fighter rôle.

Military Aircraft . . . .

(*Continued from page 346*)

carrying a crew of four. In addition to this helicopter, the Royal Navy are now considering operating small helicopters in the anti-submarine rôle from frigates so that they can work as a team. As a preliminary step, trials are shortly to be carried out with a frigate specially modified to operate helicopters. The new Saunders-Roe P.531 is a likely machine for this work.

This anti-submarine battle is, however, not only fought by ships and aircraft of the Royal Navy. Coastal Command of the Royal Air Force plays a vital and integrated part. Shackleton aircraft of long endurance operating from shore bases are able to increase appreciably the depth of our anti-submarine defences.

Next one must consider the air defence problem of both Naval forces and convoys. Both these units are liable to air attack and air shadowing by long-range enemy aircraft operating from shore bases. The defence of the Fleet is undertaken by a combined effort of the ship's anti-aircraft gunfire—later to be replaced by the Short Seacat guided missile and the Armstrong Whitworth Seaslug, carried in specially designed guided missile ships—and fighter aircraft operated from carriers. The close defence of the force is left to the ship's gunfire or Seacat and Seaslug guided missiles, while defence in depth is undertaken by the fighter aircraft, as is also defence against the low-flying reconnaissance aircraft which can operate outside the range of shipborne weapons.

In order further to expand the warning area and increase the range of detection of attacking aircraft, and also to detect aircraft flying below the radar screen of the ships, A.E.W. (Airborne Early Warning) aircraft are required and these are also operated from the carriers. The aircraft fulfilling the fighter rôle at the present time are the Sea Hawk FGA.6, Sea Venom FAW.22 and Scimitar F.1, and coming into service later this year, the Sea Vixen FAW.1.

The Sea Hawk and Scimitar are single-seat aircraft and are classified as fighter/strike aircraft, having a fine weather and day capability only. The Scimitar, of which two squadrons are in service, is gradually replacing the Sea Hawk and with its increased endurance, fighting and striking power is bringing a powerful punch to our Naval forces.

The Sea Venom and Sea Vixen two-seater aircraft are all-weather day and night fighters. The latter with its improved performance and increased fire power in the form of air-to-air guided missiles, the Firestreak, and its long-range AI radar, increases the Fleet's ability to defend itself against enemy air attack in all weathers.

The A.E.W. aircraft mentioned earlier, a vital link in the defence chain at present, is the American Skyraider, supplied from America under M.D.A.P., operating an American Early Warning Radar. This aircraft is the only piston-engined aircraft still operating in R.N. carriers. It carries a crew of three who locate enemy aircraft and direct defending fighters so that they may effect an interception.

With their high performance radar, they are also of value in many other rôles—in conjunction with high-speed search aircraft to conduct ordinary reconnaissance; combining with fighter aircraft in attacking E-boats and as part of an anti-submarine team to detect any submarine which shows itself (even to the extent of showing its "snort") above the surface. The Skyraider is starting to go out of service this year and is being replaced by the Gannet AEW.3, which has been modified to carry a later and improved version of the radar now carried in the Skyraider.

The Navy has two tasks to fulfil with its strike aircraft. First it must be able to strike at shore targets in support of the Army, as was done in the Suez operation, and second it must be able to knock out any surface opposition at sea.

To be able to do this in all weathers, both by day and night, posed many problems in the design of the aircraft. The aircraft must have the ability to operate at long distances from the ship, be able to navigate while flying at low level over the sea and also while flying at altitude.

Today already in service as strike aircraft in limited numbers are the Scimitar and also the Sea Hawk. The latter has a strike capability with bombs and rockets and the Scimitar with bombs and rockets and also with a nuclear weapon. They are, however, both limited to day and clear-weather operation.

To meet the all-weather requirement, the Blackburn NA.39 low-level strike aircraft has been ordered. This aircraft, a two-seater, meets all the requirements. It can strike hard at targets well beyond the reach of existing aircraft with both conventional and nuclear-type weapons. It has a high speed, low-level capability enabling it to approach its target below the enemy radar screen and by means of its Doppler navigation system can make an accurate landfall after a long flight over the sea. It carries radar which enables it to attack sea and coastal targets in conditions of low visibility and at night.

In addition to the strike requirement, there is a reconnaissance requirement so that targets may be photographed and identified and to provide the information necessary to brief strike crews. The Sea Hawk can carry the normal camera equipment in the fuselage to enable it to carry out tactical, photographic reconnaissance. The Scimitar and NA.39 are more sophisticated and the former can be fitted with a special nose carrying the photographic equipment required. A limited number of these noses are supplied to each Scimitar squadron and can be fitted as and when required.

The NA.39 carries its equipment in the form of a pack which is stowed in the bomb-bay. The ability to fit the photographic equipment at short notice increases the flexibility of the Strike squadron.

It will be seen that with the introduction of the NA.39 in the early 1960s, the Fleet will have a really powerful strike aircraft capable of fulfilling the requirements of the Navy and Army in the strike and reconnaissance rôles for many years to come, and in the Scimitar/Sea Vixen/NA.39 combination, supported essentially by modern radar equipments, the U.K. will possess a Naval Air Defence and Strike System second to none in the World.

It is less than 42 years since an officer of the Royal Naval Air Service brought his 800 lb. aircraft to rest on the forecastle of H.M.S. "Furious," having achieved the World's first deck-landing. Since then Naval aircraft operating techniques have progressed in step with the fantastic development of aviation itself, until today the operation from carriers of aircraft of the highest weights and performances in all weather conditions are matters of everyday occurrence. The Royal Navy is confident that this development will continue unchecked and that the Carrier Task Force will maintain, for the foreseeable future at least, its position as one of the main stays in U.K. and NATO defence policy.

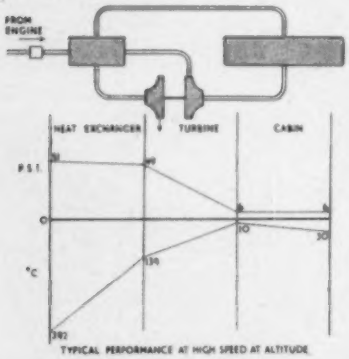
DAY FIGHTER.—Now in squadron service, the Supermarine Scimitar F.1 is superseding the Sea Hawk.

Military Aircraft . . . .

Aircrew Comfort and Survival

WITH the ever-increasing need for military aircraft to operate at higher speeds and altitudes, and in many cases, for longer periods, the problems associated with aircrew environment requirements are also becoming more and more complex. In addition, operating factors such as extremely high or low altitudes at high speeds have very significant effects on the chances of escape from the aircraft and subsequent survival on reaching the Earth's surface. Once again, the longer ranges of military operations add to the problems connected with aircrew survival on land or in the water in the varying climates of the world.

The comfort and safety of aircrew in the latest types of Service aircraft can be effectively ensured by the complete integration, and centralized control, at all stages, of the various sub-systems concerned with the control of pressure, flow,



A system drawing illustrating cabin air supply equipment for military aircraft. This represents the most advanced use of cooling turbines.

cooling and temperature of air for the cabin, with the conditioning of ventilated suits and with the supply of oxygen. These systems are all interrelated and interdependent. This consideration has become a fact in the NA.39 where the complete system has been designed and engineered by Normalair, Ltd.

An essential requirement for crew comfort and safety is the control of cabin pressure to altitudes (nominally 25,000 ft.) at which oxygen systems can be used, without restriction and without the need, under normal conditions, for pressure breathing, and the provision of a simple means of increasing the cabin differential to 9 p.s.i. during long periods of cruising, so that cabin altitudes of the order of 8,000 ft. can be established at those times. Cooling and temperature control systems need to be capable of maintaining the cabin at stable temperatures in the region of 65° despite the very great heat loads arising from increased speeds and performance. Flow control systems must be calibrated to ensure an adequate ventilation rate, and must be stable in operation to prevent surges in cabin pressure.

A further essential comfort and safety requirement is the provision of oxygen equipment that will automatically provide the required amount and concentration of oxygen at all cabin altitudes, and that will also provide the boost pressures necessary when breathing oxygen above some 34,000 ft. The same equipment must take into account the necessity for giving full oxygen protection in the event of cabin depressurization at operating altitudes, and a further requirement is that of providing the necessary supply and control of oxgyen during the early stages of baling out at extreme altitudes.

The majority of British military aircraft are fitted with Normalair pressurization, flow control, cooling, temperature control, and oxygen equipment. The equipment now being provided has developed considerably since that supplied by the company in the early post-war years, in that improved techniques have resulted in reliable, more efficient and, above all, simpler and lighter equipment.

As already stated, cabin pressurization systems can be employed with the need for pressure breathing under normal conditions, but for certain operational requirements it is likely that a full pressure suit which fully encloses each crew member will have to be worn. With the advent of this it will be essential for a ventilated suit to be used under all conditions to provide the air flow needed for ventilation of the body which in these circumstances is isolated by the suit from the normal cabin ventilating air flow.

The basic difference between the requirements for a cabin conditioning system and one supplying a ventilated suit is that in the latter case the total amount of moisture in the air must be kept fairly small when body cooling is required. The achievement of such dry air presents certain problems, particularly where the system has to operate continuously for other than very short periods. Two very different solutions have been adopted by de Havilland Propellers for two complete systems developed for a fighter and a bomber respectively; in each case engine compressor bleed air is used and the system is completely independent of the cabin conditioning system.

In the fighter system the bleed air is initially cooled by an air-to-air heat exchanger and is further cooled to just above freezing point, to condense out as much water as possible, by passing it through a Freon evaporator; the water is discharged to atmosphere through drains. As the air is then too cold to feed to the ventilated suit it is passed through an air-to-air heater where its temperature is raised by means of uncooled engine compressor bleed air; the flow of the latter air is regulated by a pneumatically operated valve controlled by a pneumatic temperature sensor in the suit air line—the heater, valve and temperature sensor.

For the bomber system a turbo-fan cold-air unit is used instead of Freon for the last stage of cooling. This cold air is not fed to the suits but is passed through a heat exchanger where it cools the suit air to the desired temperature, which

Right, in this Sabre 6 ejection seat mock-up, G.Q. Parachute items for pilot use include the partial pressure helmet, flexible back pack assembly, arming wire and cable assemblies, automatic safety harness and air ventilated suit.

Left, typical aircrew equipment assembly for high altitude operations. It includes the M.L. Aviation personal equipment connector, pressure breathing oxygen mask and the Mk.1 pressure jerkin produced by P. Frankenstein and Sons.

is sufficiently low to "squeeze" the water out which is then vented overboard because of the relatively high pressure of the suit air at this point.

Two new air supply systems for ventilated suit requirement are being developed by Sir George Godfrey and Partners, Ltd., which concern is producing servicing trolleys for the R.A.F.

A pilot wearing the Frankenstein Mk.1 pressure jerkin and Mk.4 anti-*g* suit, and the Baxter Woodhouse and Taylor partial pressure helmet.

for air conditioning aircraft on the ground. Automatic temperature control systems for air ventilated suits are also produced by the Technical Developments Division of Gloster Aircraft.

Pressure Breathing Equipment

The full pressure suit is still under development in this country, but the pressure jerkin for use at altitudes above 48,000 ft. is being employed on high altitude test work and is expected to be brought into general use when such aircraft as the P.1B comes into service. The standard Service equipment at the present time is the pressure breathing waistcoat which, used in conjunction with a pressure breathing mask and appropriate pressure oxygen supply, allows aircrew to fly for long periods at 42,000 ft. and for about 15 min. at 44,000 ft. Its most important function is that of a stratospheric life-preserver enabling a pilot to descend rapidly from 48,000 ft. in case of cabin pressurization failure.

A pressure jerkin, such as the one-piece garment designed and manufactured by P. Frankenstein and Sons (Manchester), Ltd., in conjunction with the R.A.F. Institute of Aviation Medicine and R.A.E., applies pressure over the whole of the trunk and must be used with an automatic pressure demand oxygen regulator and pressure helmet. It is worn over the Mk. 4

The Baxter Woodhouse and Taylor partial pressure helmet showing the sun vizor up and the pressure vizor up. In the event of cabin pressure failure the helmet automatically closes and seals to provide, together with a pressure jerkin, a personal pressure environment.

anti-*g* suit trousers manufactured by the company which, in conjunction with other devices, retain their anti-*g* function during normal flight yet assist the jerkin in pressurizing aircrew during emergency loss of cabin pressure or during ejection.

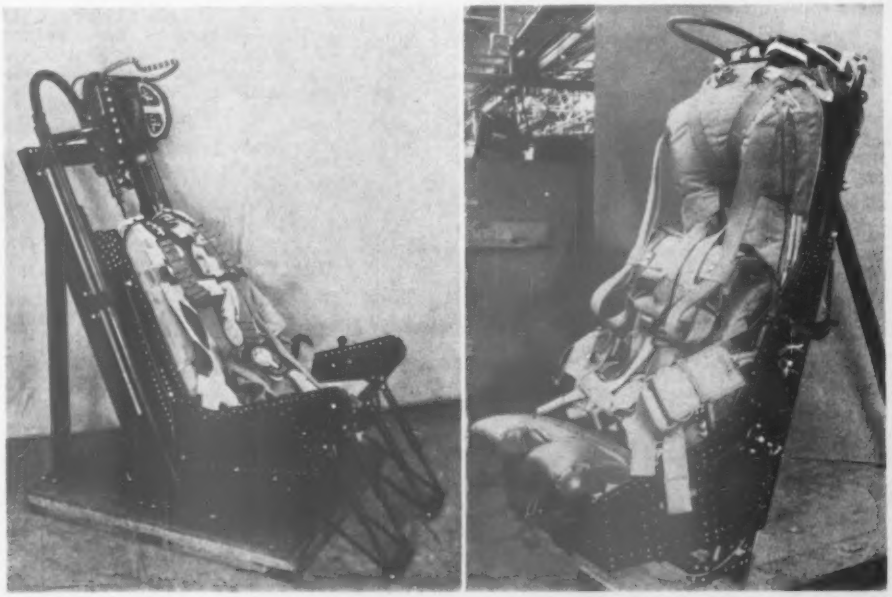
One of the types of partial pressure helmets developed for use in conjunction with the pressure jerkin or complete partial pressure suit is the Baxter Woodhouse and Taylor unit. Providing such essential equipment as oxygen mask, sun vizor, intercommunication and some crash protection this helmet then, in the event of cabin pressure failure, closes and seals automatically to provide, together with the jerkin, its wearer with a personal pressure environment which will allow him to complete a short mission and descend to a low altitude.

The helmet is designed to come into operation immediately and automatically, without any action on the part of the wearer, through loss of cabin pressure. It is so constructed that, in the case of urgent necessity, it can be removed in a few seconds. The automatics can be overridden by manual operation. A similar type of pressure helmet for test flying is produced by The G.Q. Parachute Co., Ltd.

Reductions in the two important subjects of weight and space in military aircraft are being achieved by the replacement of the present gaseous oxygen breathing systems in British Service aircraft by liquid oxygen systems. This latter type is now being supplied by British Oxygen Aro Equipment for installation in the Lightning, Sea Vixen, Scimitar, Gannet AEW.3 and the Gnat Trainer.

Escape and Survival

Three environmental conditions—lack of altitude (combined with low forward speed in the case of ejection seats), extremely high altitude and high speed—are the most difficult problems



Right, a standard Folland ejection seat as fitted to the Gnat 1. Ordinary, not combined, seat and parachute harnesses are fitted in this illustration which also shows the pneumatically damped leg-rests to reduce shock when ejecting. Extreme right, a Martin-Baker Mk.5 fully automatic ejection seat for U.S. Navy aircraft.

Military Aircraft . . . .

concerned with the escape from aircraft, other important factors being aircraft behaviour and attitude.

The majority of operational and training aircraft are now fitted with ejection seats and in nearly all R.A.F. types so fitted, such equipment is cleared for use from a height of 100 ft. at speeds down to 120 knots under straight and level flight conditions up to any altitude. The next step is the development of ground level ejection at speeds below 120 knots. A study of fatal accidents in single-engined fighters when the pilots ejected near the ground following engine failure soon after take-off emphasizes this last requirement.

One of the secrets of safe ejection near the ground is to get the parachute deployed speedily after ejection, say within 1½ sec. In Martin-Baker fully automatic ejection seats, this sequence starts immediately ejection is initiated, the parachute being ready to come out by the time the top of the trajectory is reached. This, of course, would be too fast at very high speeds and in the company's latest seats, the time release mechanisms are fitted with a sensing device, which automatically selects the time required for safe deployment of the parachute, to meet the conditions of speed and height prevailing at the time of ejection.

Started some six years ago, the other ejection seat under development in this country is the Folland lightweight-automatic unit, which is based on the Swedish Saab design. It is installed in Gnat fighters and also the Short SC1 VTOL aircraft. A new version, incorporating a combined seat and parachute harness, combined mic-tel and oxygen connections, leg restraint, and a man-stabilizer system is being developed for installation in the Gnat Trainer. High altitude trials of the stabilizer system are now in progress at Woomera using a modified Canberra.

The Folland seat utilizes a single combustion chamber feeding two guns which also form the main seat frame members. A G.Q. back-type parachute is used, the pack also containing the emergency oxygen bottle, a barometric release mechanism for the main parachute, and the stabilizer when fitted. A seat-type survival pack is also fitted in the bottom of the seat.

For those bomber crew members who are not provided with ejection seats two developments are helping their escape chances. First there is the Irving automatic release which enables the crew member to abandon aircraft at high altitude and be confident that his parachute will automatically open at a safe height. The second aid to escape is the introduction of static line arming of the parachute assembly, so that the minimum height is lost, after escape, before the automatic release is armed. At low altitude, this allows safe and rapid deployment of the parachute without the need for manual action by the crew member.

In the Irving Mk.20 back-type parachute assembly, the internally stowed automatic release and its static line arming with manual override, provide this aid. The static line operation also arms the emergency oxygen equipment, thus providing for its supply during the high altitude phase of the descent after bale-out.

To improve the degree of comfort for mobile crew members a quickly adjustable harness and the integration of parachute harness with pressure clothing, and a combined overall/harness system are under development.

Another step forward in the simplification of aircrew equipment assemblies has been the introduction of the personal equipment connector for coupling the oxygen pipe, R/T, air-ventilated suit and anti-*g* suit to the aircraft services. By coupling the aircrew portion of the connector to a corresponding portion of the ejection seat or aircraft, all connections are made in one operation. One aircrew equipment assembly firm working in this field is the M.L. Aviation Co., Ltd., which has developed the personal equipment connector and other items during flight trials and studies in collaboration with various component manufacturers, the R.A.F. Institute of Aviation Medicine and the airframe and engine constructors. The company also produces pressure helmets and similar equipment.

The Irving Mk.20 back-type parachute assembly for bomber crew members not provided with ejection seats. It is fitted with an automatic parachute release and static line arming for high- and low-altitude escape respectively.

Post-War developments in design of survival equipment have been restricted because the increase in the number and the complexity of aircrew personal items has placed limitations on the size and weight of personal survival packs.

Being attached to the flyer and providing a seat during flight, the dimensions of these packs are restricted to the shape and size of the seat and their weight is limited to the maximum which can be suspended from a man falling by parachute after ejection. As the depth of the pack can rarely exceed 6 in. the quantity and bulk of survival aids that can be stowed is also very limited.

Space and weight limitations have also restricted design developments of aircraft dinghies, although it can be claimed that the designs adopted (a boat-shape for single-seat dinghies and circular for multi-seat) are the most efficient and economical. Nevertheless, improvements continue to be made. For example, the materials used in a 26-seat dinghy are such that it can be packed in the space previously occupied by a 20-seat dinghy without increase in weight.

The R.F.D. Co., Ltd., who specialize in the design and manufacture of personal survival packs and dinghies, has, within the limitations described, kept pace with the requirements of modern military aircraft for survival equipment. The company has developed the single-seat and the five-, nine- and 20-seat dinghies, and now a 26-seat dinghy, originally designed for commercial airlines, is being adapted for military use.

A development for helicopters, designed for use on the Bristol 192, is the "dinghy container" which is carried one on each side of the fuselage. On alighting, the containers are released from the aircraft and then manually operated. The nine-seat dinghy bursts from the container and inflates, ready for boarding.

Since the War there has been an increased requirement for land survival equipment, and designers have given considerable attention to the development of items which fill the dual rôle of land and sea survival aids. In this respect, R.F.D., Ltd., has improved the thermal insulation in dinghies for use on sea and land by providing an inflatable cushioned floor and tent canopy for both single- and multi-seat dinghies. The company has also experimented with conspicuity properties of fabrics and, departing from the well known yellow fabric, is producing dinghies with black buoyancy chambers and fluorescent orange canopies.

Other companies working in this field of air and sea survival equipment include Elliot Equipment, Ltd., who produce the 20-seat dinghy for the Beverley, and P. Frankenstein and Sons, who manufacture a range of aircrew lifejackets, immersion suits, exposure suits and dinghies for the R.A.F. and Fleet Air Arm. Emergency radio units for use with these various types of survival equipment include Sarah VHF search and rescue equipment manufactured by Ultra Electric, Ltd., and Sarbe UHF radio beacon produced by Burndept, Ltd.

A Frankenstein "space-suit" being pressurized in the company's test laboratory.

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M.2A

Military Aircraft . . . .

Helicopters—An Army View*

THE attributes of the helicopter most likely to appeal to any army are: Vertical take-off and landing (a), hover (b), all-weather performance (c) and, load-carrying performance (d).

(a) Eliminates the need for prepared airstrips. The latter, together with the fixed-wing aircraft operating from them and the wheel tracks made thereby, are exceedingly difficult to conceal. To obtain adequate concealment such strips often have to be sited far from the headquarters and units whom the aircraft support. Helicopters, able to operate from small clearings, should usually be able to land close to those headquarters and units.

(b) Permits the loading and unloading of troops and supplies, for example, when the ground is unsuitable for landing. More important still, it permits very slow forward speeds at very low levels, and confers a consequent ability to operate in conditions of poor visibility which would defeat fixed-wing aircraft.

(c) Ability to operate in high winds is a most valuable asset.

(d) Because, in the conditions of future warfare, the existence of both the roads and the transport airfields must be considered problematical, armies have every incentive to be interested in the load-carrying qualities of helicopters.

If these four helicopter attributes are of particular interest to armies, however, we must remember that it is the attributes and not the helicopters which are important. If new types of vehicles are designed to achieve the same purpose, armies will not necessarily remain faithful to helicopters.

The Saunders-Roe Skeeter A.O.P. helicopter (above) is operated by the Army Air Corps for various duties and has been adopted by the West German Army and Navy.

Capable of carrying a 4,500-lb. load, the Vertol H-21 Work Horse (right) has been ordered by the U.S.A.F., U.S. Army, R.C.A.F., French Navy and the West German defence force.

Continuing to regard the helicopter strictly as a vehicle, we may say that an army needs it for three main purposes: (i) For the movement of individuals; (ii) For the movement of formed bodies of men; (iii) For the movement of stores.

There are two main reasons why individuals need to be moved by air within the combat zone, first because an individual in one particular place needs to proceed swiftly and comparatively safely to another place, and, secondly, when it is desired so to position an individual in the air that, with or without artificial aids, he can observe and report his observations.

Reconnaissance has been all-important to armies for as long as there have been armies. It has never been more vital than now. In a modern battle commanders and staffs need up-to-date information, by day and night, from every corner of the battle zone, from deep in the enemy's rear to the depths of their own base. Failure to obtain such information promptly may exact heavy and decisive penalties.

Deep reconnaissance over enemy-held territory does not, at first sight, seem a likely helicopter rôle. It calls for fast aircraft, relatively invulnerable to interception by other aircraft or by projectiles, with technical devices for surveying the battlefield and transmitting their observations to the various centres where the information is required. The havoc likely to be caused to located airfields on both sides makes it essential that such aircraft have a vertical or extremely short take-off, and ultimately, no doubt, they will be pilotless.

Reconnaissance of the forward portion of enemy-held territory can usually be carried out by individuals mounted in light aircraft or helicopters. They will, of course, be vulnerable both to hostile aircraft and hostile guns, but can minimize such vulnerability by intelligent flying. The simplicity of this form of reconnaissance, and its speed and reliability make it inevitable that it will be employed, whether or not more scientific methods of observation are also available. As a platform for the observer, the helicopter is not necessarily better than the fixed-wing aircraft, but the flexibility of operation afforded by the helicopter by its take-off and landing performance will certainly make it the more popular.

Technical reconnaissance of various natures will be continually in demand. The most important is artillery reconnaissance, no doubt, since observation is a basic need of artillery and since the observer can most conveniently engage with the artillery the targets which he discovers. The other arms will not be backward however. Tanks will require eyes to look ahead for them as they advance, to report on road blocks, demolitions, concealed enemy weapons, and such like. Engineer officers will wish to be lowered into muddy river beds to look for bridging sites, signal officers to be deposited on peaks to site radio-relay stations.

A task with special significance in nuclear warfare is that of traffic control; damage to a road or bridge can quickly cause traffic-jams, and large concentrations of slow-moving or stationary vehicles are an inviting nuclear target; airborne traffic control could by anticipation prevent such disaster.

Future commanders may wish to spend much of their time airborne over the battlefield to see for themselves how the battle is going, to have closer contact with their formations or units and thus be able to intervene promptly when intervention is desirable. They will need, therefore, a form of airborne command post, with room for one or two staff officers and two or three wireless sets.

To move individuals in the combat zone, therefore, an army needs:—

(a) A small, simple, one-seater device with vertical take-off and landing performance, and a radius of action of about 25 miles.

(b) A two-seater helicopter for reconnaissance to have a

*An abbreviated version of a paper, "The Place of the Helicopter in the Modern Army," given by Lt.-Col. P. W. Mead before the Helicopter Association of Gt. Britain on March 6 in London.

Military Aircraft . . . .

good rate of climb and, even more vital, of descent and an endurance of about 90 minutes.

(c) A larger helicopter (five- or six-seater) with some two hours' endurance, for reconnaissance, for use as a command post, and for liaison. It should be able to carry stretchers.

To be based in the forward areas, these aircraft need to be as small as possible (and able to be made smaller by such means as the folding of rotor blades), easy to conceal, easily manhandled by the minimum numbers, and simple to maintain by soldier-technicians in the field. They must be simple to fly low both by day and by night, and must have a good field of observation. They must be able to operate in extremes of heat and cold, and at high altitudes.

Movement in Fighting Order

The tactical movement of troops means their movement to the area where they are required to fight. They must travel in the fighting order and formation appropriate to their fighting rôle; the basic unit will consist of about 10 men and for convenience we may call it a section.

Roads, with their traffic blocks and their slow-moving vehicles, are perilous causes of concentration. Swift cross-country movement is essential, making light of physical barriers such as hills, rivers, marsh and jungle, of congested areas such as roads, and of the physiological barrier of fatigue. This needs helicopters.

The author discusses the potential use of the utility helicopter for coups de main, concentration, assault, reinforcement, mopping up, and the stopping of gaps.

The utility helicopter has other obvious rôles in the so-called "police" operations in which the British and French armies, in particular, are continuously involved. Speed in concentrating against a detected terrorist group is clearly most important; if it can be kept continuously under observation while troops are flown in to cordon it off and destroy it, then the ideal has been achieved.

The utility aircraft which are to perform these essentially tactical rôles must not be too large or unwieldy, for as we have seen they are to land and take-off in the face of the enemy and fly over routes potentially covered by enemy fire. The smallest tactical troop-load, however, is the section of about 10 men, and that must therefore be its load. An armed man weighs, on the average, some 250 lb., and is therefore not to be confused with the 180-lb. passenger to be detected in the airline brochures.

Vertical take-off and landing performance is essential. The aircraft must be simple to fly, leaving the pilot some part of his attention free to devote to extraneous matters such as enemy small arms fire and its evasion. It must be able to be flown low by day and night and in bad weather. It must be able to operate effectively in hot and cold climates and high altitudes. It should have a range of some 150 miles, with its full load. It should be quickly adaptable to casualty-evacuation.

When such aircraft are used in the reconnaissance or assault rôle, it is essential that the enemy should be prevented from bringing aimed-fire to bear upon them. They must, therefore, have the means of bringing fire down upon detected enemy troops or support weapons, and, where necessary, of putting down a smoke-screen. This may imply separate weapons, under the pilot's control, carried either in the troop-carrying helicopter itself or in separate (possibly smaller) "support" helicopters, or merely the provision of means by which the assault troops themselves may bring aimed-fire to bear before the helicopter lands.

The Movement of Stores

It is a cardinal principle that the fighting soldier must be supplied continuously with what he needs to maintain the battle. He must on no account have to forage for himself, or be in uncertainty as to the arrival of his supplies.

In the past the supply-pattern in a theatre of war has included bases and advanced-bases, where commodities are delivered and held in bulk, and areas farther forward where bulk is "broken" and loads of all types of supply are made up for the formations for which they are destined. In the rear part of these formation areas they are held ready for collection by unit transport, or, in the case of vehicle supplies, for issue to the vehicles themselves. Delivery to bases and advanced-bases has been principally by ship or rail or both, and forward of advanced-bases has been by road.

In future wars it will no doubt remain necessary to establish base-areas, advanced-base areas, and formation supply areas, but the threat or reality of nuclear weapons will enforce upon such areas a great expansion, so that the stores within them may be widely dispersed. It may be doubted whether in conditions of nuclear warfare ships will be able to unload at major ports, or cargo aircraft land at busy air-terminals. Rather does one envisage small ships slipping by night into a number of separate small harbours, landing craft disgorging their loads onto open beaches, and cargo aircraft landing on dispersed rough-surfaced fields or strips.

Helicopters in the supply rôle will permit the wide dispersal of base loading areas. Their routes forward can be myriad and changed from day to day. Their supplies can be landed (not dropped—unless especially necessary) exactly where they are required. Flying low, helicopters will usually avoid hostile radar surveillance. If the final forward delivery can be by helicopter, unit drivers and transport will be spared gruelling night convoys on congested and treacherous roads and units will be less vulnerable to the activities of enemy infiltrating onto their land supply routes.

Three transport helicopters would appear to be needed. First, for the transport of supplies between base and formation areas a helicopter is required which will carry the same sort of load as the current road supply vehicle. Its payload should, therefore, be about 3 tons. These helicopters should be adaptable for casualty-evacuations, and should have a radius of action with full load of some 200 miles.

Secondly, for supply delivery in the forward areas, a smaller helicopter is needed, the obvious solution being the utility helicopter, which, designed to carry its unit of 10 fighting men, will alternatively be able to carry over a ton of stores or a light vehicle.

Lastly a weight-lifter seems to be necessary, to move heavy pieces of bridging or other awkwardly shaped stores, to help unload ships, to move obstructions which are blocking a highway and thus causing congestion, to move medium-sized land vehicles over rivers or other obstacles or to deliver them to parties of troops who have been moved by utility helicopter. We might estimate its required payload at about 6 tons. Its radius of action will probably have to be some 200 miles.

Summary of Requirements

A modern army requires the following types of aircraft with vertical take-off and landing performance:—

(a) A small, simple, one-seater, for individual movement in the battle area.

(b) A two-seater, for reconnaissance, having a particularly good rate of climb and descent.

(c) A five- or six-seater, for use as a command post, for liaison purposes, or as an armed "support" helicopter.

(d) A utility vehicle, to carry tactically a sub-unit of 10 250-lb. soldiers or to deliver a ton of stores in the forward areas.

(e) A cargo vehicle to carry about three tons of supplies or alternatively some 25 250-lb. soldiers.

(f) A weight-lifter to lift, and carry for short distances, stores to the weight of about six tons.

Vehicles c, d and e should be adaptable to casualty-evacuation.

A typical weight-lifter suitable for moving Army stores for short distances is this private venture Westland Westminster here in flying crane form.

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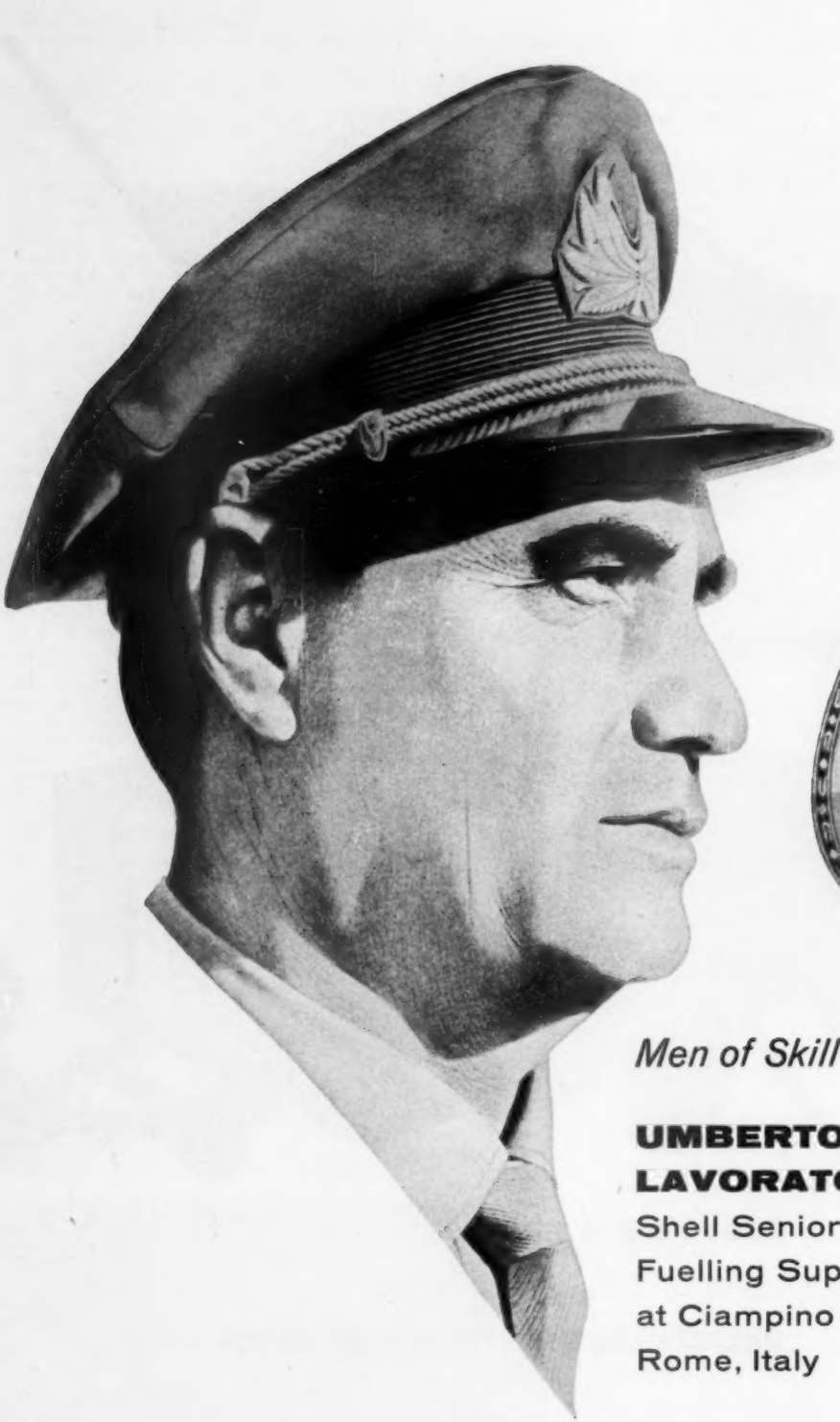

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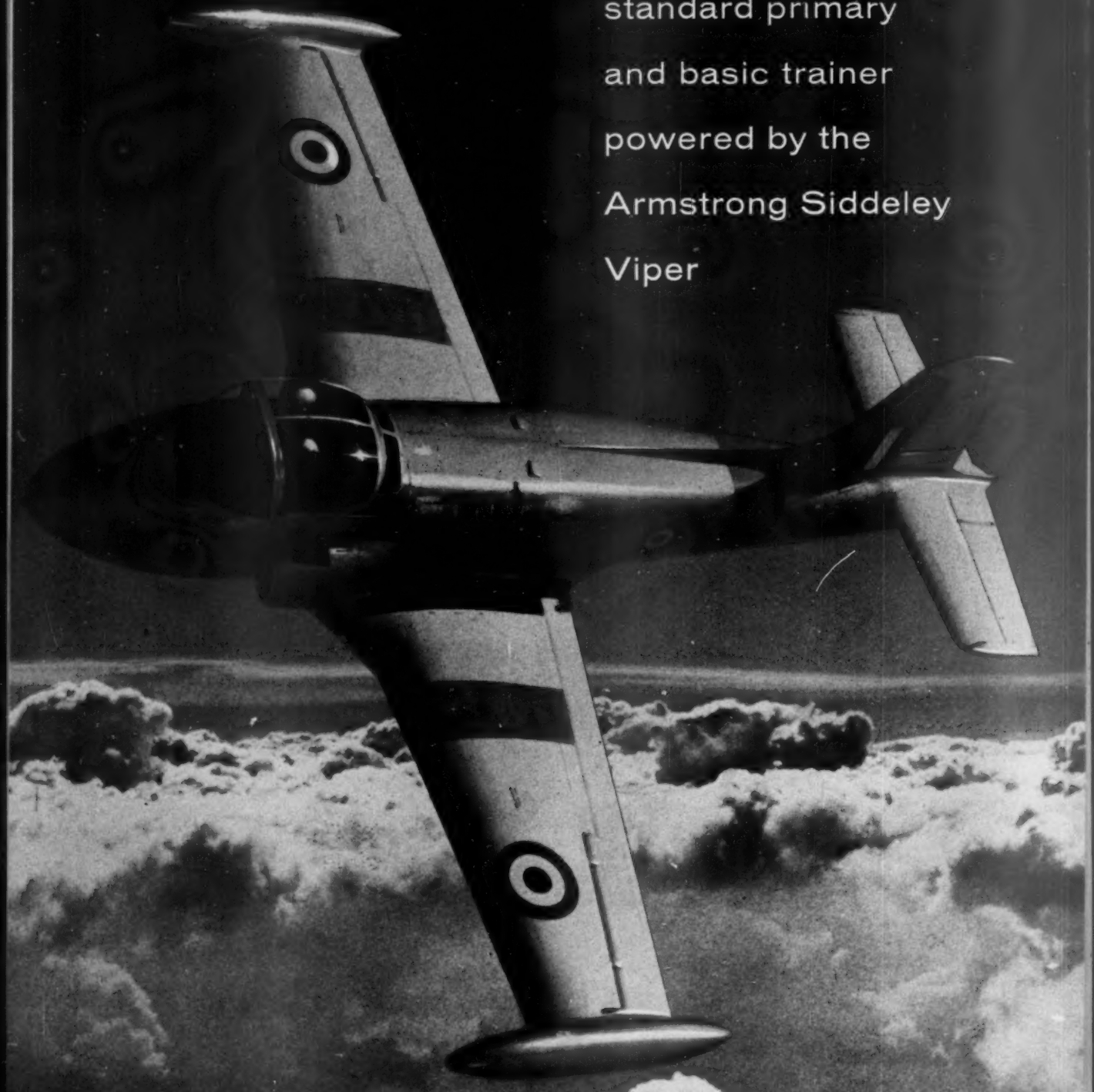

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The Fighting Services

Aviation Medicine Meeting

FIVE members of the R.A.F. Institute of Aviation Medicine at R.A.E. Farnborough are to attend the Aero Medical Association meeting in Los Angeles from April 27 to 29. Although in previous years individual representatives of the R.A.F. Medical Branch have attended the meeting at the invitation of the United States, this will be the first time that a party has gone.

The party will be headed by Gp. Capt. H. L. Roxburgh, O.B.E., deputy officer commanding the Institute, an expert in high-altitude protection. The others will be Sqn. Ldrs. P. Howard, O.B.E., and J. Ernsting, O.B.E., heads, respectively, of the Acceleration and High Altitude Sections, Flt. Lt. A. J. Benson of the Neuro-Physiology Section, and Miss H. M. Ferres, an expert on the physiology of temperature control. They will read papers relating to their fields of research.

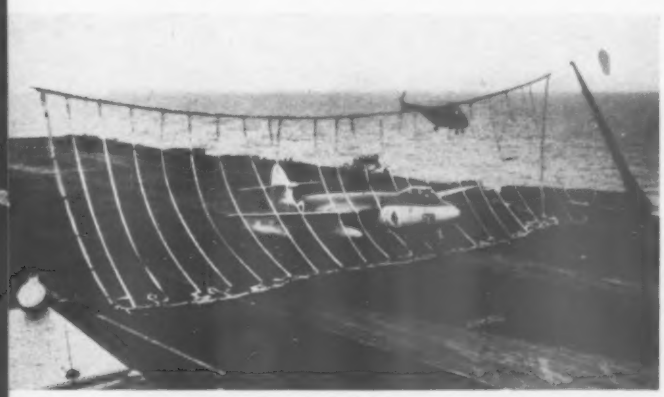
On the way home the party will visit various air medical centres in North America, including the Johns Hopkins Hospital at Baltimore, the Mayo Clinic in Minnesota, the Walter Reid U.S. Army Institute of Research in Washington, the Psyco-accoustic Laboratory at Harvard, the R.C.A.F. Institute of Aviation Medicine at Toronto, and McGill University, Montreal.

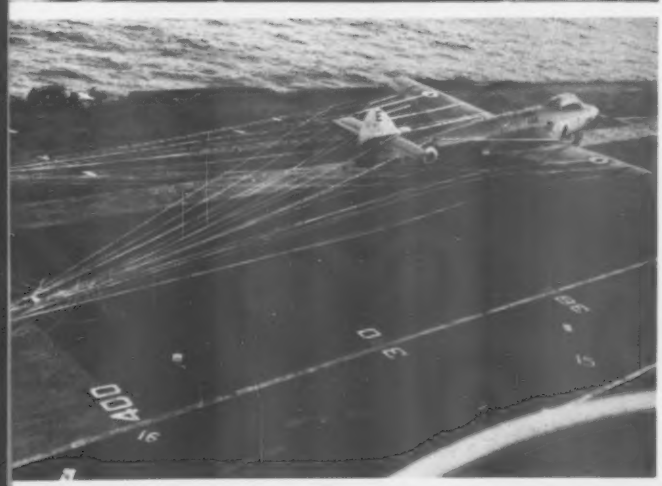
Crash Barrier Landing

A SEA HAWK of No. 806 "Ace of Diamonds" Squadron from H.M.S. "Eagle" piloted by Lieut. N. Grier-Rees, R.N., developed hydraulic trouble while airborne from the carrier on February 25 and had to land making use of the flight-deck crash barrier. This is the first occasion that a Sea Hawk from "Eagle" has had to use the barrier and it is also thought to be the first Sea Hawk ever, except for test, to land-on by means of this aid.

The hydraulic trouble caused the loss of the aircraft's air-brakes and when Lieut. Grier-Rees returned to the carrier to land he discovered that the arrester hook would not lower to the landing position, although he managed to "blow down" his undercarriage by emergency drill. Two "touch-and-go" landings were made in an unsuccessful effort to bounce down the reluctant hook and the crash barrier was then rigged by the flight-deck crew in 2 min. 20 sec. (a Work Study team have reported it would be good going to rig it in 5 min.). The Sea Hawk then came in for its final landing.

The first impression that Lieut. Grier-Rees got as he came in to land and saw the crash barrier, was that it looked too flimsy to hold him. His second, when he hit it, was that he had gone through it. However, all was well and he was surprised by the gentleness of the arresting action until the barrier brought him to rest at the end of its stretch. It then pulled the Sea Hawk backwards until the brakes were applied. The aircraft required only minor repairs and the pilot was uninjured.





Details of a flight-deck crash barrier landing by a Sea Hawk are given on this page. Top illustration shows the fighter running into the barrier, and, below, it is seen after being caught in the mesh.

National Gliding Championships

A TEAM of 13 pilots, two of whom respectively hold the British distance and gain-of-height records, form the R.A.F. entry for the 18th British National Gliding Championships at Lasham, sponsored by the British Gliding Association, from May 9 to 18. The entry is the strongest ever to represent the Service and its flying personnel include two Valiant pilots, a Canberra pilot, the pilot of a Beverley, a Javelin instructor, and the officer commanding a Chipmunk squadron.

Together with its own retrieving and other ground personnel the R.A.F. contingent of 70, who will live under canvas at Lasham, will be completely self-contained. Team manager will be Air Cdre. G. J. C. Paul, C.B., D.F.C., R.A.F. (retd.), founder of the R.A.F. Gliding and Soaring Association. Deputy team manager will be Gp. Capt. R. R. Goodbody, O.B.E., chairman of the R.A.F.G.S.A. Gp. Capt. N. W. Kearon, the deputy chairman, is captain of the team.

The R.A.F. entry is split into two sections, Teams 1 and 2. All members of Team 1 have flown in the Nationals before, and in 1957 Sgt. A. W. Gough, present holder of the British distance record, finished fourth. He will fly an Olympia 419. Gp. Capt. Kearon was sixth at Lasham in 1957. Sgt. J. Williamson, holder of the British gain-of-height record—26,500 ft.—will fly an Olympia 401-X. Flt. Lt. K. Fitzroy, winner of the National and the Kemsley cups in the 1955 Nationals, will fly a Skylark 3b, as will Gp. Capt. Kearon. Sqn. Ldr. L. Bayley, coming from Cyprus for the championships, is to fly an Eagle T.42. The team will assemble at Lasham a week before the championships for intensive training.

The second team is to consist of Flg. Off. D. Cretney, Gull 4; Flt. Lt. E. W. Clarke, Kranich; Sqn. Ldr. J. G. Croshaw, A.F.C., and Cpl. K. V. Newholme, Olympia 2; Sqn. Ldr. N. Maygothling, and Flt. Lt. F. Allen, Olympia 2; Cpl. W. R. Longley and Sqn. Ldr. E. T. Ware, Olympia 2. Reserve, Plt. Off. D. Campion.

R.A.F. Appointments

THE following are among recent Royal Air Force appointments:—

Air Ministry: Wg. Cdr. B. Morgan, M.B.E., to the Department of the Air Member for Personnel; Wg. Cdr. C. L. Brooks to Headquarters Unit to command.

Bomber Command: Wg. Cdr. H. E. Campbell-Orde to Headquarters for administrative staff duties; Sqn. Ldr. D. W. Bedford to Headquarters for organization duties, with acting rank of Wg. Cdr.

Fighter Command: Sqn. Ldr. F. G. Dummer to Headquarters for engineering duties, with acting rank of Wg. Cdr.

Coastal Command: Wg. Cdr. D. B. Gericke to Headquarters for Work Study duties; Wg. Cdr. J. L. Lendrem, O.B.E., to R.A.F. St. Mawgan for technical duties; Sqn. Ldr. E. J. Booker, M.M., to Headquarters for technical staff duties, with acting rank of Wg. Cdr.

Flying Training Command: Sqn. Ldr. C. A. Sullings, A.F.C., to Headquarters for organization duties, with acting rank of Wg. Cdr.

Technical Training Command: Wg. Cdr. E. Cotton, D.F.C., to No. 2 Radio School, Yatesbury, to command the Administrative Wing.

Maintenance Command: Wg. Cdr. H. Grant, A.F.C., to No. 22 Maintenance Unit, Silloth, to command; Wg. Cdr. M. J. Keelan, to No. 35 Maintenance Unit, Heywood, for administrative duties; Wg. Cdr. A. S. Mann, D.F.C., to R.A.F. Bicester to command; Wg. Cdr. B. Armiger, O.B.E., to Headquarters for operational duties.

Miscellaneous: Wg. Cdr. H. F. Summers, M.B.E., to H.M. Troopship "Devonshire," as Ship's Commandant.

Diversification at Dowty

AT an extraordinary general meeting of the Dowty Group shareholders recently, Sir George Dowty gave more of the background to the recent acquisition by his Group of Rotol, Ltd. (see THE AEROPLANE for January 2). This step was made he explained, after long and careful consideration "having full regard to the decline in orders for military man-carrying aeroplanes and the inevitable effect of the increasing use of pure jets on the market for variable-pitch propellers."

Sir George pointed out that about two-thirds of the output of Rotols and its subsidiaries is for the civil aircraft market. This, he said, contrasts with the present aircraft interests of the Dowty Group which are predominantly military. The decision to negotiate the purchase of Rotol was based to a great extent "on the obvious and many advantages to be gained by combining two undertakings developing and manufacturing similar, and, in some cases, identical products in factories only two miles from one another. The Government," he went on, "has constantly advocated the streamlining of the aircraft industry to obtain more compact and efficient units and this is a positive step in that direction.

"Rotol has a large and well equipped factory which it is believed can be used effectively on work for our Group, in addition to its own products. It has been, and still is, self-sufficient in its production facilities, whereas the Dowty Group companies have depended quite largely on subcontracting. I believe that the combined volume of our aircraft work will not decrease substantially during the next two years, and when the full impact of reduced military orders is felt, our combined aircraft turnover will still be considerable."

Commenting that Rotol had already started on the development and manufacture of non-aviation products, Sir George said that these, together with the many industrial interests of the Dowty Group, "should well offset any decrease in our joint aviation activities in the years ahead."

The statement revealed that the purchase price of Rotol's share capital had been £2,235,000 and that £1,265,000 more was needed to repay loans to Rotol from Rolls-Royce and Bristol. Of the total of £3,500,000 needed, £3,425,000 is being financed by a rights issue to Dowty shareholders of two new 10s. ordinary shares at 36s. 6d. each for every five existing shares held on February 13, 1959, fractions being disregarded. The remaining £75,000 and all costs of the issue and underwriting expenses are being met from the Group's own resources.

New Firth Brown Films

A SERIES of film shows has been staged recently by Thos. Firth and John Brown, Ltd., in industrial centres throughout the country. Last week we were privileged to view the latest in this series—in Cheltenham on March 9. The occasion drew a large audience, mostly from the surrounding aircraft industry, and proved to be a most interesting and instructive evening.

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The second film was rather more of a documentary and took the audience on a tour of the Firth Brown works in Sheffield. In it, one could see the many and varied methods and techniques used to produce all kinds of forgings, castings and rolled products in the high-grade steels for which Firth Brown are famous. Altogether this was a most fascinating film which lasted for just over 30 minutes.

Copies of both these films—which are 16 mm. with sound—are available on loan, free of charge to approved technical associations, schools and other responsible organizations. Application should be made to the Sales Promotion Dept., Atlas Works, Sheffield, 4. They are well worth getting.

Research and Development Enterprise

AT Redhill, Tiltman Langley, Ltd., have been established for some years as an energetic research and development team with a wide diversity of interests and a refreshing capacity for tackling unusual problems that are in need of solution. Recently we had an opportunity to see something of their present activities. And we found that, as in the case of many concerns associated in one way or another with aeronautical engineering, the changes in defence policy have had a considerable influence and are reflected in the team at Redhill turning its attention increasingly to commercial and industrial work and to non-aeronautical applications of their various projects.

There is a good deal of inventive capacity among the Tiltman Langley team, and there are a number of development and research projects going on at Redhill which cannot be revealed. Despite the inevitable cut-back in aircraft work, the company is not at a loss for alternatives and is already diversifying its activities. In point of fact, it is yet another example of how a small section of the aircraft industry is adapting itself and keeping the defence potential alive.

The company has a small but well-equipped machine shop and some first-class inspection facilities as well as the more usual workshop tools and equipment. This makes them particularly well suited to deal with small precision mechanisms in addition to larger work.

Among new equipment recently installed, in the metallurgical laboratory is a 20,000-lb. Macklow-Smith universal testing machine which is available for "outside" research work. This machine has also been adapted to produce hysteresis curves for plastic and rubber materials as well as metals. Similarly, the company have two 80 h.p. variable-speed rigs that are available for testing rotating machinery over a speed range of 3,000 to 10,000 r.p.m.

Among Tiltman Langley's more promising "lines" at the present time is the remarkably neat little clutch and free-wheel device (THE AEROPLANE for August 1, 1958) that was developed for a specific aircraft application. From this, they have gone on to develop a range of miniature clutches and free-wheels and some larger units capable of taking torque loads of the order of 400 lb.in. These have application to special equipment such as packaging machines, indexing apparatus, tabulating machinery, and so on—anything, in fact, which needs a controlled intermittent rotary motion.

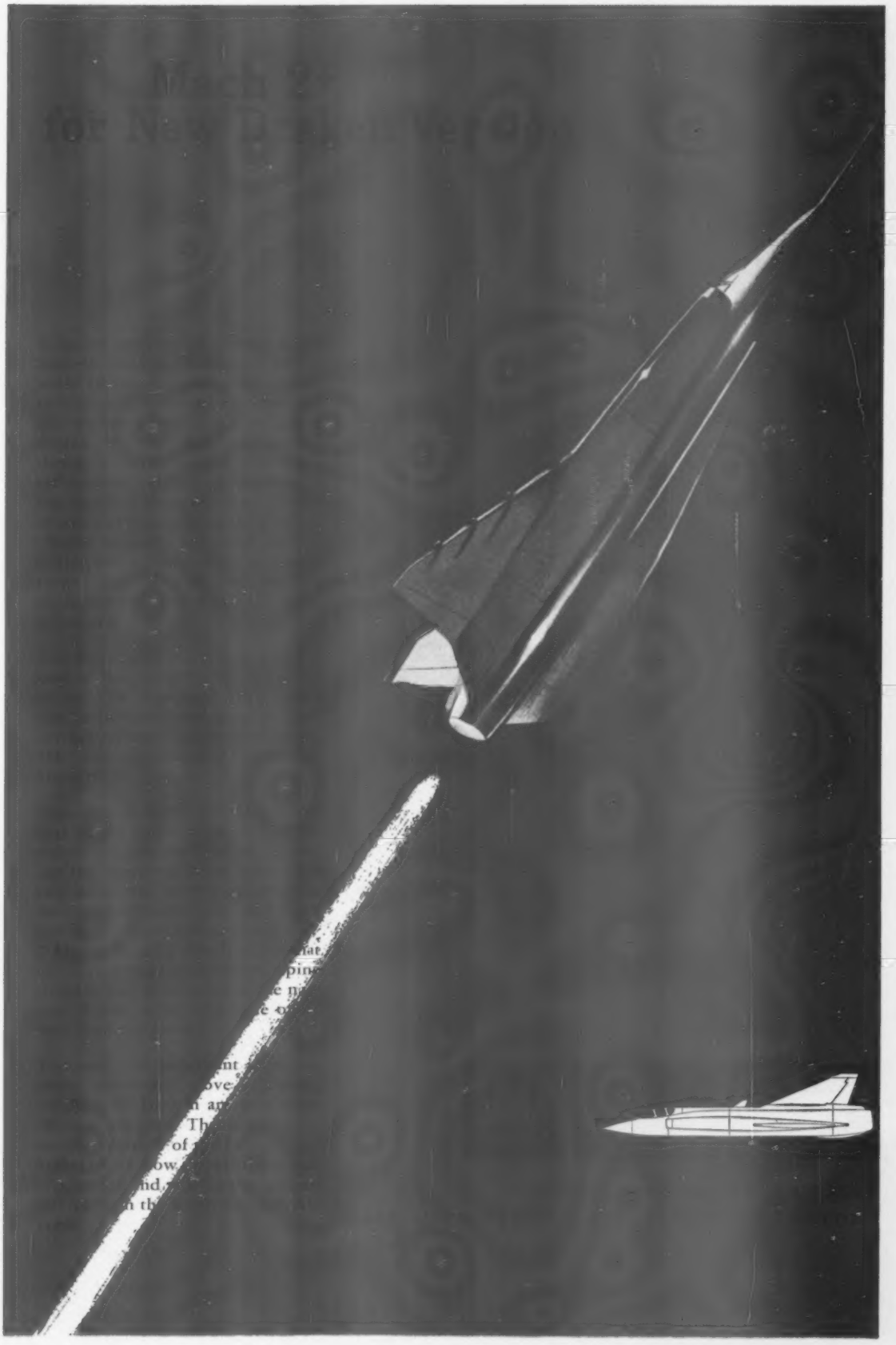
Another Tiltman Langley product of great promise is their special method of soft soldering aluminium discussed in our recent special Materials and Processes issue. It is claimed to be the only method permitted by the Ministry of Supply for such work.

Among current aircraft work done by the company is a comprehensive electrical circuit test console for the Vulcan. This piece of ground test equipment has been designed in conjunction with A. V. Roe and is in production at Redhill. By plugging leads into the various circuits on this airframe, indicator lamps on the console can be made to show whether or not the circuits are serviceable; each aircraft circuit has a separate lead and panel on the console.

With current emphasis on 3-phase AC electrical systems in modern aircraft, for example in the V-bombers, there is a demand for appropriate checking equipment. To meet this, the company have designed an interesting and very neat phase sequence and line continuity indicator. This is small and light enough to be carried easily in the pocket and gives a clear visual identification by means of miniature neon lamps.

Two lamps are used to indicate phase sequence and by connecting up the three leads from the unit to the main supply lines the appropriate light will identify the colour-code sequence related to the leads. Line continuity is indicated by three lamps; if a line is broken the lamp will light and identify the faulty line.

Clearly this instrument has a wide application for all electricians. A version of it is, we understand, to be supplied to the R.A.F.



Diversification at Dowty

AT an extraordinary general meeting of the Dowty Group shareholders recently, Sir George Dowty gave more of the background to the recent acquisition by his Group of Rotol, Ltd. (see THE AEROPLANE for January 2). This step was made he explained, after long and careful consideration "having full regard to the decline in orders for military man-carrying aeroplanes and the inevitable effect of the increasing use of pure jets on the market for variable-pitch propellers."

Sir George pointed out that about two-thirds of the output of Rotols and its subsidiaries is for the civil aircraft market. This, he said, contrasts with the present aircraft interests of the Dowty Group which are predominantly military. The decision to negotiate the purchase of Rotol was based to a great extent "on the obvious and many advantages to be gained by combining two undertakings developing and manufacturing similar, and, in some cases, identical products in factories only two miles from one another. The Government," he went on, "has constantly advocated the streamlining of the aircraft industry to obtain more compact and efficient units and this is a positive step in that direction.

"Rotol has a large and well equipped factory which it is believed can be used effectively on work for our Group, in addition to its own products. It has been, and still is, self-sufficient in its production facilities, whereas the Dowty Group companies have depended quite largely on subcontracting. I believe that the combined volume of our aircraft work will not decrease substantially during the next two years, and when the full impact of reduced military orders is felt, our combined aircraft turnover will still be considerable."

Commenting that Rotol had already started on the development and manufacture of non-aviation products, Sir George said that these, together with the many industrial interests of the Dowty Group, "should well offset any decrease in our joint aviation activities in the years ahead."

The statement revealed that the purchase price of Rotol's share capital had been £2,235,000 and that £1,265,000 more was needed to repay loans to Rotol from Rolls-Royce and Bristol. Of the total of £3,500,000 needed, £3,425,000 is being financed by a rights issue to Dowty shareholders of two new 10s. ordinary shares at 36s. 6d. each for every five existing shares held on February 13, 1959, fractions being disregarded. The remaining £75,000 and all costs of the issue and underwriting expenses are being met from the Group's own resources.

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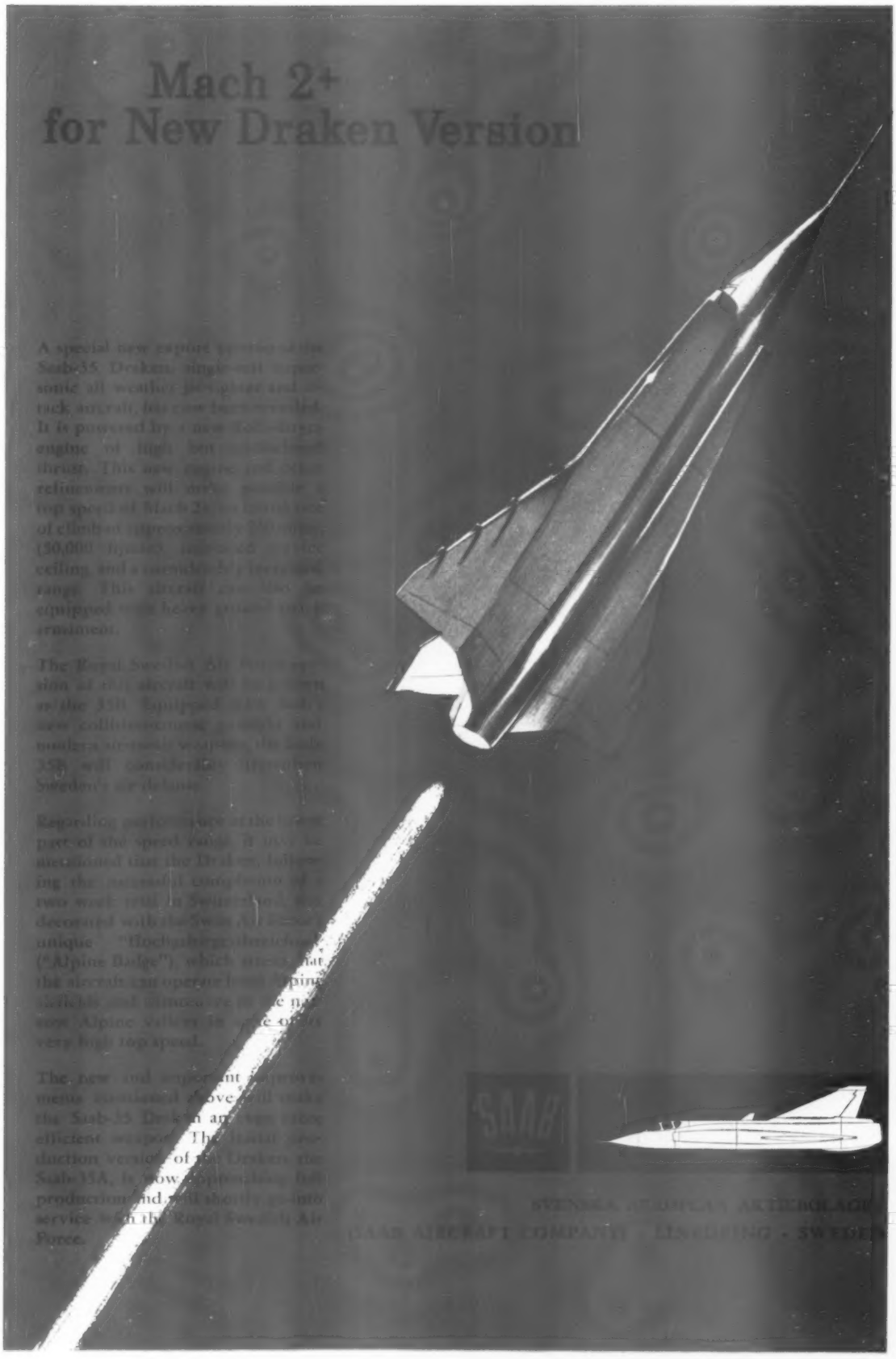
Mach 2+ for New Draken Version



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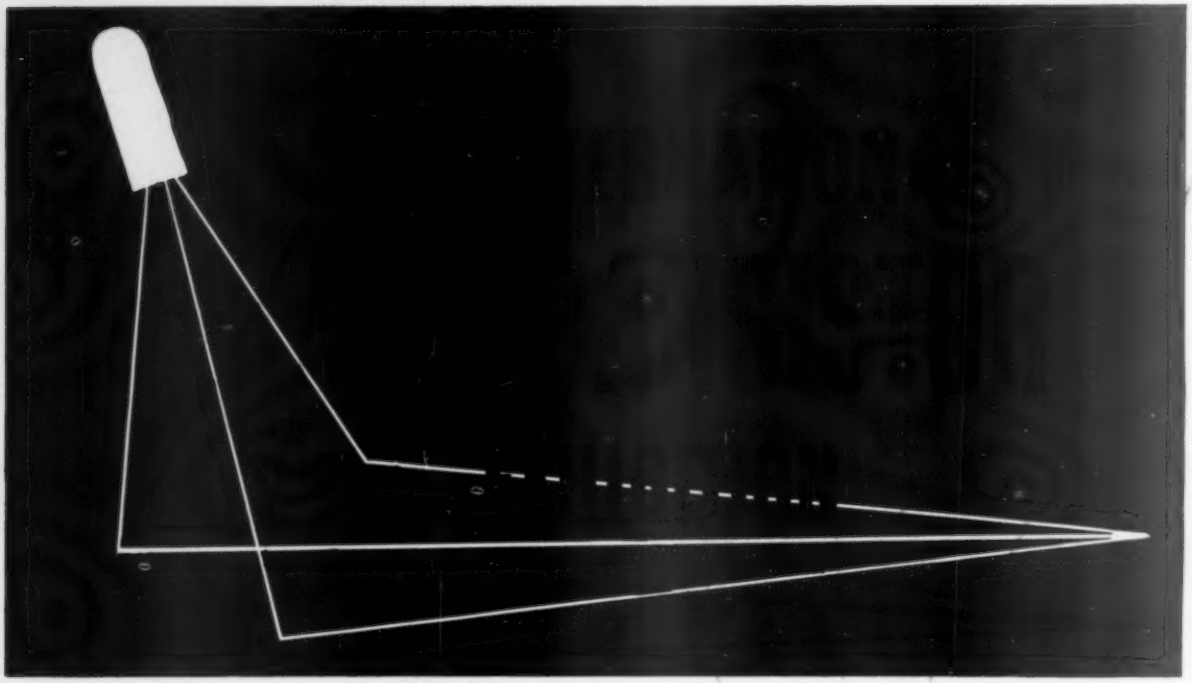


In association with the International Convention on Transistors and Associated Semiconductor Devices Promoted by the Electronics and Communications Section of The Institution of Electrical Engineers

The INTERNATIONAL TRANSISTOR EXHIBITION will be held in the same building and at the same time as the *International Convention on Transistors and Associated Semiconductor Devices*, promoted by The Institution of Electrical Engineers.

These events are already attracting world-wide attention and an overall attendance of some 60,000 is anticipated.

The Exhibition will cover all types of semiconductor devices and their numerous applications, and will include transistor materials, equipment involving transistors and semiconductor techniques, and also various associated and specialized components for use in transistorized equipment.

Part of the Exhibition will be devoted solely to transistor research and development, and will include exhibits from government, industrial and university research laboratories, as well as from the exhibitors.

Manufacturers wishing to participate in this unique scientific Exhibition are invited to contact the organizing company.

Two thousand experts from all over the world are expected to attend the International Convention on Transistors. The associated Exhibition is thus assured of a large attendance of scientists and engineers directly concerned with transistors and their application.

The opening lectures of the Convention will be given by the inventors of the transistor—Dr. W. B. Shockley, Dr. W. H. Brattain, and Professor J. Bardeen.

Achievements of the Turbo-ramjet

ANY theory is powerfully reinforced if practical proof is available. General Noël Daum's Louis Blériot Lecture to the R.Ae.S. on March 12 dealt with both the theory and practice of turbo-ramjet propulsion for aircraft. Extracts from his lecture which follow describe the performance of the Nord Griffon II turbo-ramjet aircraft, which makes a convincing case for this propulsion technique. General Daum is the technical director of Nord Aviation.

At the end of January, 1957, the Griffon II made its first flight. In April the ramjet was lit in flight for the first time. In May the speed of sound was exceeded. In June several supersonic flights were made up to Mach 1.3. The Mach number was then progressively increased until December, when the aircraft achieved Mach 1.85 at an altitude of 42,000 ft. There was a large surplus thrust, giving a rate of climb of 28,000 ft./min. Further advance in Mach number was very slow as the turbojet limitations were being approached. Nevertheless, since October, 1958, flights in the neighbourhood of Mach 2 have become almost a matter of routine, the turbojet being throttled back from Mach 1.8 in order to conserve its life. So far this turbojet has valiantly stood up to all the onslaughts of heat, and its reliability has been excellent.

The aircraft has now made more than 200 flights. One of its best performances has been Mach 2.1 at 61,000 ft., while still accelerating and climbing slightly. Thermal limitations on the airframe have so far prevented further progress.

The aircraft weighs 15,000 lb. all up, of which the powerplant accounts for 3,740 lb. fully equipped, including ramjet structure, ramjet accessories (ignition, control, fuel supply, regulation, etc.) and the afterpart of the fuselage, which forms a shell around the 54-in. dia. ramjet. At Mach 2 the ramjet gives more than 80% of the total thrust, which is 9,200 lb. at 50,000 ft. and 5,500 lb. at around 60,000 ft.

Besides the company's pilots, several others have flown the aircraft, including foreign pilots. All have expressed their satisfaction with the good behaviour of the powerplant, and with the confidence which it inspires by an impression of smoothness not achieved with afterburning. All have been impressed by the ease of manœuvre in supersonic turns at high g during which the aircraft continues to accelerate.

This particular feature has recently enabled the Griffon to obtain the World Speed Record for the 100 km. closed circuit. This record has shown up not only the aircraft's speed potential and its aerodynamic qualities, but also, and even more strongly, its ability to maintain a very high thrust in the turn, which enables it to accelerate where orthodox aircraft have to decelerate. Contrary to a widespread notion, the ramjet can be made completely insensitive to the effects of incidence. As for the turbojet, its position inside the ramjet makes it incapable of knowing whether or not there is any change in incidence.

Though the turbo-ramjet has enabled the griffon to fly regularly at around Mach 2 at 60,000 ft. this result has been achieved without difficulty with an Atar 101 E3 turbojet of 7,700 lb. static thrust, which had not been designed to operate at such high Mach numbers. Higher speeds are possible, there being a large surplus thrust; unfortunately we cannot take advantage of this because of kinetic-heating limitations.

The same performance could only be obtained with a plain turbojet with reheat if the most up-to-date engines were to be used; the Griffon was conceived in 1953-54.

A variable-geometry intake would be needed whereas the Griffon intake is of the pitot type, and there is no movable control element, either at the intake or at the ramjet and turbojet exits. The thrust required to obtain the performance achieved is equivalent to more than three times that of an Atar with afterburning. This thrust has been obtained with a much smaller installed weight, and with development and manufacturing costs much lower than those of modern jet engines with the same characteristics.

Future Applications

Future turbo-ramjet applications can be grouped into two broad categories, which we are putting forward for aircraft designed to fly above Mach 2. These are a powerplant integrated with the aircraft structure and an independent powerplant which may be used in the same manner as pod-mounted turbojets.

The first solution allows very light structural designs, but the interdependence of engine and aircraft problems demands very close co-operation between aircraft and engine designers. In the case of the Griffon, the first aircraft of this type, the interaction between air flows around the intake and the rest of the structure has allowed the transonic zone to be crossed without any longitudinal instability, thanks to a judicious disposition of the parts concerned. This is one of the very few cases where this has been achieved without recourse to autostabilizing devices. Conversely, the proper functioning of the ramjet, and particularly proper combustion in the ramjet chamber, depends on disturbances set up in the internal flow by the rest of the airframe.

The same need for co-operation between aircraft and engine designers arises in respect of control and supply installations, and also in respect of the mounting of combustion organs such as chamber, cooling sleeves, injectors, and flame barriers.

On these lines we have designed a Griffon derivative with a turbo-ramjet based on a more advanced turbojet. With this powerplant we can predict with absolute confidence a performance of over Mach 3 at altitudes between 66,000 and 80,000 ft., and a hitherto unapproached degree of manœuvrability at very high altitude.

We have also investigated the combination of one or more turbojets with a flat ramjet. For large aircraft this allows the air intakes to be located under the wing. It can also lead to substantial improvement in the lift-to-drag ratio, and hence in range.

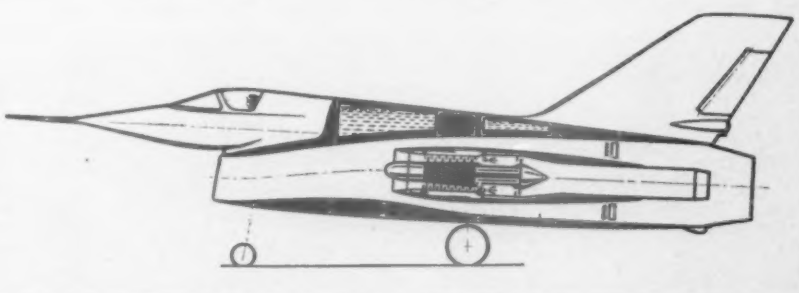
With the second solution, the turbojet and ramjet make up an independent nacelle which, if required, could include the intake and exit control equipment.

A design of this type, now under investigation, finds an interesting application as a means of increasing the speed of very large transport aircraft to supersonic values for cruising conditions. Here again the low weight of the powerplant, which the ramjet alone makes possible, gives a very clear advantage to the combined engine, while at very high Mach numbers this advantage may be further increased by a substantial improvement in the specific consumption.

Conclusion

For Mach numbers between 2 and 4, the combined engine is superior to the plain turbojet because of its enormous specific thrust, which gives a saving of at least 30% on the weight of the equipped powerplant in the case of large aircraft. This saving becomes more important the higher the thrust required in cruising flight in the neighbourhood of the maximum lift-to-drag ratio. It may be used to increase either range or payload, to such an extent that for a given take-off weight the use of a combination engine allows either a 20% increase in range or doubling of the payload in the case of a large long-range aircraft.

An added advantage is the very great simplicity of the ramjet for very high powers, and the possibility of using a smaller engine which is inevitably cheaper in terms of development, manufacture and maintenance.



MACH 2.1 AT 61,000 FT.—The turbo-ramjet Nord Griffon II (right) has accelerated while climbing at Mach 2.1 at 61,000 ft. A projected aircraft based on it, is designed to exceed Mach 3 at altitudes between 66,000 and 80,000 ft.

News About People

JOINING SMITHS AVIATION.—Mr. D. L. Brown, 53, M.I.Mech.E., A.M.I.C.E., M.I.GasE., A.F.R.Ae.S., has been appointed deputy manager of Smiths Aviation Division's Research Department at Cheltenham. He joins the Division from the School of Gas Turbine Technology, Farnborough, where he had been Principal since 1949.

B.O.A.C. APPOINTMENT. — Mr. Clyde M. Culpepper has been appointed resident sales representative for B.O.A.C. in Houston, Texas. He was formerly traffic manager at Houston for Eastern Airlines.

A HUNTING APPOINTMENT.—Group Captain A. H. S. Lucas took over responsibility, on March 1, for public relations of Hunting Aircraft, Ltd., and its associated companies of Hunting Engineering, Hunting Mhoglas and Henderson Safety Tanks.

ROTOL RETIREMENT. — Mr. T. Cruwys, for many years head of the publicity department of Rotol and British Messier, has retired, but will continue to edit the group's *Quarterly Review*. He is in his 70th year.

E.E.C. SCHOLARSHIPS.—The second series of £450 university scholarships offered annually by the English Electric Co., Ltd., for 1959 have been awarded. The winners are M. K. Bevir; I. M. Cowan; G. Czekalowski; G. B. Donaldson; J. A. Eades; A. J. Eades; A. J. Gault; D. C. Hanna; E. M. Hildyard; M. T. L. Hills; A. C. E. Kempson; J. R. Lightfoot; E. P. Magill; M. J. Mulvany; D. A. Quarmby; W. F. Ray; N. G. Timmins; J. N. Tyacke; M. G. Warren, and C. D. W. Wilkinson.

F.A.A. APPOINTMENT.—Capt. A. C. Packard has been appointed deputy director of the Bureau of Research and Development at the Federal Aviation Agency. He has held several research appointments in the U.S. Navy.

FAIRCHILD APPOINTMENT.—Mr. Marion Maxfield has been appointed director of F-27 commercial sales for Fairchild Engine and Airplane Corp. He has been assistant director of customer relations since 1955 and replaces Mr. R. James Pfeiffer, who has resigned.

NU-SWIFT DIRECTORS.—Mr. H. G. Stage, overseas marketing manager, and Mr. F. Tompkins, home sales manager, of Nu-Swift, Ltd., have been appointed directors of the company.

M.O.S. APPOINTMENTS.—Sir Lewis Hutchinson, K.B.E., C.B., a deputy secretary in the Ministry of Supply since 1949, is retiring on March 31, 1959, and his duties will be taken over by Mr. Peter Humphreys-Davies, C.B., who has been a deputy secretary in the Ministry since 1956. Mr. D. W. G. L. Haviland, C.B., has been appointed a deputy secretary and will take over the appointment vacated by Mr. Humphreys-Davies on April 1, 1959. Mr. G. Leitch, O.B.E., has been appointed Under-Secretary (Munitions Supply) to fill the vacancy caused by the promotion of Mr. Haviland.

ROYAL RECOGNITION.—Mr. John Hay, Joint Parliamentary Secretary at M.T.C.A., presents the Queen's Commendation to Capt. P. J. McKeown, Training Captain V.802 aircraft, British European Airways Corporation.

P.I.A. MANAGING DIRECTOR.—Air Commodore Malik Nur Khan took up the appointment of managing director of Pakistan International Airlines on March 6. He has had a long and distinguished career with the Pakistan Air Force and the Royal Indian Air Force.

Commercial Aviation Affairs

F-27 FOR EAST-WEST. — Another Australian operator, East-West Airlines, of Tamworth, N.S.W., has obtained permission to purchase a Fokker F-27 Friendship. It will be delivered in June this year and a second one may be purchased in 1960. The F-27 will replace DC-3s on East-West's heavier-traffic routes.

S-62s FOR L.A.A.—Two Sikorsky S-62s—the General Electric T-58 shaft-turbine-engine development of the S-55—have been ordered by Los Angeles Airways for service in 1960. They will be laid out for 10 passengers and be convertible for cargo operations. L.A.A., now in its 11th year of operation, at present uses five S-55s and two S-51s. Three other North American helicopter operators have options on the S-62.

ELECTRA SNAGS.—American Press reports have spoken of teething troubles with the Lockheed Electra in service, including some vibration problems apparently associated with the outboard engines and propellers. Lockheed have recommended a temporary reduction of high cruising speed from 324 knots to 288 knots while the problem is studied. During January, an Eastern Air Lines Electra had a turbine blade failure causing extensive damage to one engine. Compressor blade failures have also occurred and insecure bolt retention in the propeller gearbox has been a problem. On an early training flight, an Eastern Air Lines Electra suffered a nose-wheel collapse.

INTERCONTINENTAL TRIALS.—F.A.A. certification tests with the Boeing 707-320 Intercontinental began on February 15, 35 days after the first flight. The second -320 flew on February 4 and the two aircraft have now flown more than 100 hours. They are based at the Boeing Flight Center at Seattle, and both are to be delivered to P.A.A. after certification.

SINGAPORE DECISION. — From April 1 K.L.M.'s traffic frequencies to and from Singapore will be reduced to once weekly. This was announced by the Minister of Transport in the Commons last Monday. He said that this frequency would be adequate for traffic between the Netherlands and Singapore, which amounted to 26-27 passengers a week in each direction; the provision of further capacity would be in direct competition with B.O.A.C. and Qantas.

DOUGLAS EXECUTIVE? — The Douglas Aircraft company is considering entry into the business aircraft field. Donald W. Douglas, Jr., is reported as saying "I'm not saying we're going into production tomorrow, but we're studying here the building of a small jet transport for executives."

JETSTAR ORDERED.—Continental Can Co., has contracted with Lockheed's Marietta factory for delivery by January 31, 1961, of the first JetStar built for executive use.

IATA CLEARING.—The IATA clearing house in London in 1958 had a record turnover of more than £292 million, 28% above the 1957 figure. Business house transactions eliminated the necessity for cash payment of 88.9% of all inter-airline claims cleared through IATA during 1958.

(*Continued on page 357*)

AUSSIE VISCOUNT.—Ansett-A.N.A.'s first Viscount 832, which left Wisley for Australia on March 13, is the first Viscount delivered at the new gross weight of 72,500 lb., which bestows a 25% increase in payload and revenue potential over extreme ranges. The Viscount was certificated at this weight 10 weeks ahead of schedule, and most Series 810s already delivered will be modified by their operators for this new weight.

More power to the Victor

Now proved in flight, the R.A.F.'s new Victor B.2 bomber is even mightier than its speed-of-sound kinsmen already in squadron service.

Far-striking range, stratospheric performance and the great power of four Rolls-Royce Conway jets maintain for the Victor its place as the most formidable manned weapon in the skies.

HANDLEY PAGE

RADLETT · LONDON · READING

WHICHEVER END THEY PUT IT

Whether it's at one end, as in the quietly efficient Westland Wessex . . . whether it's at both ends, as in the outstanding Bristol 192 . . . whether it's upright, horizontal or in any position in between, the Napier Gazelle free turbine engine will always satisfy the exacting demands of helicopter operation. Designed specifically for helicopter application, the Napier Gazelle, with its "any angle" installation, relieves the designer of many accepted limitations and gives him more opportunity to make proper use of fuselage space.

NAPIER GAZELLE FREE TURBINE ENGINE

D. NAPIER & SON LIMITED, LONDON, W.3. A MEMBER OF THE ENGLISH ELECTRIC AVIATION GROUP

(*Continued from page 356*)

AFRICAN CHARTER. — A new charter company called National Air Charters (Pty.), Ltd., has been formed at Barangwanath Aerodrome, Johannesburg. The fleet comprises a Cessna 310B, a Bonanza and a Cessna 182.

CUMBERLAND OPERATOR.—Mr. Michael Kidd, traffic superintendent of Eagle Aviation until last year, is forming a private company, Cumberland Aviation Services, Ltd., to offer air charter facilities from Silloth R.A.F. Station. Initially the company will use a Rapide, an Auster and a Tiger Moth.

GCA AT GANDER.—A Ground Control Approach system is now in operation at Gander.

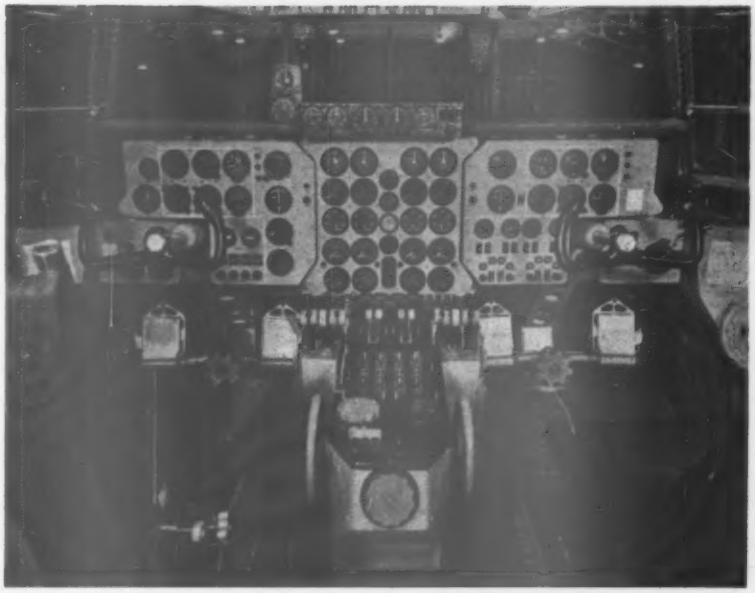
TRANSPORT BOARD CHAIRMAN.—Mr. Paul Y. Davoud, a director and vice-president of Orenda Engines, Ltd., has been appointed chairman of the Canadian Air Transport Board. He has been actively concerned with air transport operations in Canada and was for a time assistant to the T.C.A. vice-president of operations.

JET ADVISORY SERVICE.—Civil jet aircraft operating on transcontinental routes in the U.S.A. between 24,000 ft. and 35,000 ft. can now benefit from the F.A.A.'s radar advisory service. Already operating over the North Eastern area of the U.S.A. and on the route to Miami, this service is designed to inform pilots of other traffic in their area as observed by radar controllers.

CHANNEL TRAFFIC.—During 1958 Air Charter's Channel Air Bridge carried more than 5,000 tons of freight from Britain to the Continent, including 15,000 vehicles.

SWISSAIR EXTENSION.—During the coming Summer Swissair plan to extend their Middle East network to include Ankara, Kuwait and Teheran.

NEW OPERATOR.—South Pacific Airlines, Ltd., has been registered as a private company in New Zealand to provide services between New Zealand tourist centres.



ARGOSY FLIGHT DECK.—This new photograph shows the layout of the control cabin of the A.W. 650. Despite the "extras" in the way of flight-test instrumentation above the coaming and on the left of the captain's panel, it can be seen that the layout is simple and well-planned. Separate throttle and fine-pitch stop groups, on either side of the central pedestal, are provided for each pilot.

K.L.M. PACIFIC ROUTE.—On April 3, K.L.M. will inaugurate a once-weekly service from Sydney to Tokyo. The 20-hour service will stop only at Biak in Dutch New Guinea, where a change of aircraft from Super Constellation to DC-7 will be made. Connection will be provided at Tokyo with the K.L.M. Polar service to Europe.

TREND FORECASTS. — From April 1, "Trend" forecasts will be added to certain routine weather reports in the VHF Meteorological RT broadcasts in the U.K. to indicate certain expected changes during the next two hours. They will be given when visibility is expected to fall below 2.5 n.m.; when the cloud base is expected to fall below 1,500 ft.; and in certain other cases.

AIR FREIGHT FACILITY.—Emery Air Freight Corpr. has formed an international division to facilitate the Worldwide handling of air freight. In addition to serving over 250 cities in the U.S.A., Emery now has agents and offices in Canada, Australia, Europe, Japan, the Near East, Africa and a special "gateway" service to South America. London address of the division is Building 27, London Airport North, Hounslow, Middlesex.

A.T.C. COMPUTER. — An RW.300 digital control computer has been delivered by the Thompson-Ramo-Wooldridge Products Company to the National Aviation Facilities Experimental Centre at Atlantic City. Ordered by the F.A.A. Bureau of Research and Development, it is to be used in the development of an advanced airways control system.

LOAN FOR S.A.S.—A loan of $49 million has been negotiated by S.A.S. with a group of American banks, led by the First National City Bank of New York ($33m.) and two American insurance companies ($16m.). The loan will cover the purchase of seven DC-8s with ground equipment and spares.

ORLY ACCESS.—Plans for the development of Orly Airport by 1961 include a spur highway from the southern motorway to provide 10-minute access by road from the centre of Paris and a railway spur providing a 23-minute service to Paris.

FRONT AND REAR.—In this picture the Argosy is seen being loaded simultaneously through the fore and aft doors. The A.W. 650 is, we believe, the only aircraft so far built in which full-width fore-and-aft loading facilities are simultaneously available.

Private Flying

Air Day at Woburn

ON May 2 there is to be an R.Ae.C. rally of light aircraft owners to the Duke of Bedford's estate at Woburn Abbey; a landing fee of £1 will be charged. Visitors will have tea at the Abbey and will be able to tour the grounds and the house.

Woburn will always have a place in the hearts of the private flying community—particularly those whose memories go back to the early '30s. It was Mary the 11th Duchess of Bedford who, in company with her pilot, Capt. Barnard, made record flights in a Fokker VIII to India in 1929 and to the Cape in 1930. Mementoes of these memorable flights and others will be on view to the visitors in the Flying Duchess's Room at the Abbey.

During the course of the rally there will be—weather permitting—a flying display by a Bristol Fighter and a Sopwith Camel from the Shuttleworth Trust. A Blériot monoplane of 1909 vintage will also be on show and, if the conditions are favourable, will be flown.

Tiger Club Affairs

NEW MEMBERS listed in the current Tiger Club Bulletin are: Miss Sue Burges; A. P. Deverell; John Elmes; Arthur Golding-Barrett; Michael Jones; Miss Rosemary Kirby (who has rejoined after her stay in Australia); Miss Yvonne Middleton; H. T. Moleyneux; E. McAully; Wg. Cdr. W. R. Parkhouse, O.B.E.; H. J. Reynolds; John Schooling; J. de Milt Severne; and Mrs. Pauline Snook.

The Club hopes to have about 14 aircraft available for the events of the National Air Races, including the British Lockheed Aerobatic Competition. Among the aircraft given in the Bulletin as being available for racing this year are four Tiger Moths, three Hornet Moths, a Jackaroo, an Active and four Turbulents.

Other news from the Club is that there is to be an aerobatic training week at Fakenham Aerodrome, Norfolk, from April 5 to 12 inclusive. This is primarily intended for Tiger Club members who plan to compete in the British Lockheed or Tiger Club aerobatic competitions. It is being arranged by Colin Labouchere and anyone interested should contact him at Sculthorpe Old Rectory, Fakenham, Norfolk.

Easter Tour

FROM the Fair Oaks Aero Club comes news of an interesting Easter flying tour that has been arranged for members. If all the club aircraft available for the tour are booked, the flight should comprise at least five Tiger Moths, three Austers, two Chipmunks and a Taylorcraft. A flying instructor will be in overall charge of the flight.

The intention is to set out from Fair Oaks at 10.00 hrs. on Saturday, March 28, fly to Ipswich for lunch and then go on to Brough for a night stop. Leaving Brough on Sunday morning, the party plans to fly to Sywell for lunch en route for a night stop at Lulsgate Bottom. On Easter Monday, Roborough is the scheduled luncheon stop, Thruxton will be visited for tea and the flight will return to Fair Oaks in the early evening. Altogether the route covers 696 statute miles and the flying time will be about 9 hours.

The Club, incidentally, will be closed for business on Good Friday and will be open on Easter Saturday, Sunday and Monday only to deal with private owners.

H.J.C.'s Club Commentary has had to be held over owing to the absence of H.J.C.

Gliding Notes

by Dr. A. E. Slater

OCCASIONALLY, in spring or summer, there crops up an outstanding soaring day on which remarkable flights are done, not only at widely dispersed British gliding clubs, but in neighbouring Continental countries, too. Now it has happened in winter, for January 4 was such a day; but, as always in such cases, it has taken a long time for all the news to trickle in.

The Bristol Club's weak wave in the lee of the Forest of Dean, and a stronger wave at the Long Mynd which lifted Brenda Horsfield to 7,700 ft. a.s.l., have already been reported. Now the Scottish Gliding Union reports a still better wave on that day, in which R. L. Porteous took an Olympia to 12,100 ft. a.s.l., gaining 11,000 ft. above release height.

Upper air figures show no markedly stable layers at Leuchars, near the Scottish G.U., but the wind structure was rather remarkable; its velocity fell off with height from 38 knots at 5,000 ft. to only 28 (later 22) knots at 18,000 ft., but above that height it increased rapidly up to a jet stream of 99 knots at 30,000 ft. Both the other clubs had a stable layer about 10,000 ft. above the greatest height reached, and at the Midland Club the wind likewise fell off a little above 5,000 ft. while the jet stream far overhead was doing about 140 knots.

While the British air was waving on this day, Holland had some remarkable winter thermals at Gilze Rijen, near Breda. Capt. D. H. Hinlopen, taking up a passenger in a Rhönlerche, cast off from the winch cable at 1,480 ft. at 13.56 hr., found a thermal to take him to cloud base at 1,640 ft., and thereafter continued to soar for nearly 30 minutes in clear air between the cumulus clouds, above the level of their bases. These dry inter-cloud thermals, however, had their own condensation level and formed a second layer of cumulus clouds with bases at 2,800 ft., and Capt. Hinlopen had to keep opening his spoilers at that height because he was not allowed to fly the machine in cloud.

What was the explanation? It could not have been varying humidities in the soil, or there would have been cloud bases at many different levels instead of only two sharply defined heights. The lower clouds can be attributed to ground thermals, but the upper ones cannot. Some other influence must have made the air unstable.

The most plausible explanation seems to be, in meteorological terms, "a horizontal temperature gradient combined with a vertical wind gradient." In other words, continually colder and colder air was coming down from the Arctic and, owing to the usual increase of wind with height, the colder air arrived high up before it arrived lower down.

The result was instability, with the upper cold air trying to fall down, and thermals going up to take its place. Weather charts show that the temperature of the air, which came from west of Norway, was 41° F. on reaching the Dutch coast on the morning of January 3, but only 37° F. on January 4. The cooling would have been much greater higher up.

* * *

FOUNDER of a glider building firm 25 years ago, Alfred R. Weyl died at the age of 61 at the end of February in Dunstable. He and Paul Zander came to England from Hitler's Germany and in 1934 started the firm of Zander and Weyl which, among other activities, set the newly formed Cambridge University Gliding Club on its feet, first with Zögling primary gliders and then with the famous Cambridge I.

This stoutly-built machine, designed by Weyl as an improvement on the Grunau Baby, became known as the "Pons," and was still flying until about a year ago. The Totternhoe secondary glider about the size of the old Prüfling, followed.

The company also made replicas of the Lilienthal and Wright gliders for Sir Alexander Korda's historic film "Conquest of the Air," and attempts were made to fly them on Dunstable Downs in 1935. But although a member of the London Club was got up to look like Lilienthal, complete with beard, he failed to persuade either the monoplane or the biplane to fly.

Mr. Weyl's many articles in this journal will be remembered by readers; he had an encyclopædic knowledge of aviation history, but in addition to the historical material which he kept filed and ready for use, he had an attic crammed with old books and papers which still awaited sorting at the time of his death.

* * *

FOREIGN visitors are invited to take part in this year's French National Gliding Championships, which are being held at Saint Yan from June 20 to July 15. The period starts on a Saturday and finishes 3½ weeks later on a Wednesday, and this must be the longest national contest since the British one of 1933, which lasted a month.

Saint Auban sur Durance, the famous centre for wave flights, was attended during 1958 by 282 pilots, of which 32 came from abroad. Of these, 53 passed the 3,000-metre altitude test for the Gold C, and 51 climbed 5,000 metres (16,404 ft.) to earn a Diamond.

This year has started well with 14 pilots exceeding 5,000 metres on three days in January, one of them being André Xhaet, who set up a Belgian height record with over 7,000 m. Fayence, another wave site farther south, was the scene of five climbs of 3,000 m. and six of 5,000 m. all in one day, January 24; one of the climbers was a German, Leo Allkämper, who reached 6,800 m. (21,000 ft.) in a Schleicher Ka-6BR, the type which won the OSTIV prize last year in the 15-metre class.

* * *

AT the London Gliding Club's annual dinner, the Dent Trophy was presented to John Westhorpe for his "Diamond" goal flight to Plymouth; the Derry Trophy to Geoffrey Butt for "much works and bricks," especially the new garage; the Desoutter Trophy to Victor Ginn for rebuilding an Olympia and a pair of two-seater wings; and the Cellon Cup to John Charters as the best ab-initio of the year.

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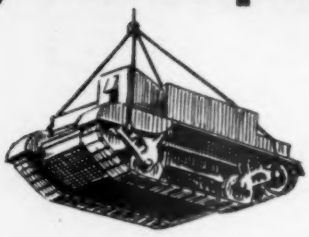

The Westminster is the largest conventional helicopter in the Western world. It has the ability to transport as many as 51 troops in battle attire, to convey mobile field units such as hospitals, food kitchens, living huts, vehicle servicing centres and operations rooms from supply bases to assault areas, to recover unserviceable aircraft and ground vehicles and to transport complete missiles from storage units to firing sites. All of these capabilities meet the requirements of modern army, naval and air operations.

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Correspondence

Data on Polish Aviation Wanted

IN describing his pre-War VTOL project (THE AEROPLANE for February 20, 1959), Capt. Sipowicz mentioned the interesting fact that in 1929 a machine bearing the same name (Heliplan) was designed in this country. As yet; I can find no record of this particular aircraft and wonder if it ever existed.

For some years now I have been engaged in the task of compiling material for a reference book on Polish aviation, and I would be most grateful if any readers possessing information likely to be of assistance to me in this work would be kind enough to get in touch with me.

Brighton 6, Sussex. J. ORWOVSKI.

Where are the Old Aircraft?

FOR the past few years I have been compiling lists of old aircraft that are still intact. I have accounted for all the well-known old aircraft, but I know there must be many more lesser-known types still in existence today. I should be much obliged if you could publish this letter in your magazine in the hope that some of your readers will be able to help me.

The details required concerning each aircraft are the following: Serial or registration numbers; Mark numbers; powerplant; if in flying condition; owner; where held, and also any other information that is available.

I have tried many sources of information and I have now decided that the only way to conduct a comprehensive survey is with the help of the general public.

London, E.4. GRAHAM P. TRANT.

Getting to the Terminal

HOW trying it is that we who live close to airfields are not able to fly to London Airport to pick up B.E.A. or B.O.A.C. flights. A helicopter service connecting, say, Gatwick with Kenley, Croydon and London Airport would surely be widely used. It is utter nonsense that someone living on the outskirts of Gatwick—and a very large number of business executives live in that area—should have to set aside at least two hours for getting to their air terminal.

Clement's Inn. MAURICE E. HEDGES.

[British European Airways already has A.T.A.C. approval to operate helicopter (or fixed-wing) services between Gatwick and London Airport, and generally between London Airport and other aerodromes in the London area. The difficulty at the moment is the very high operating cost of present helicopters, particularly as the amount of traffic would probably not support the high frequency of service which would be essential if the helicopter was to be of any use at all.—ED.]

REAL's Amazing Growth

HAVING thoroughly enjoyed reading F. B. Kirbus' "Squabble in the Sun" (January 23 issue, pages 95-6), I hope he won't mind if I add a few comments regarding his statements on REAL S.A. of Brazil. First, he gives the impression that this airline is non-IATA, and states that they can fly you from Buenos Aires to New York for $458.80. This was true enough up to around June/July, 1958, but—surprisingly enough—in August (or maybe it was September) of last year IATA somehow or the other persuaded REAL to become its 77th or 78th member!

Therefore, whilst IATA cannot compel REAL to increase its (vast) domestic network fares structure, it most certainly would not permit the Brazilian giant to "undercut" fares on international schedules.

Mr. Kirbus is also somewhat out of date when referring to REAL's fleet. In addition to their (World's biggest) DC-3 fleet—which is 84 of the type (not 78 as stated)—they have six CV-340s, 14 CV-440s, 16 C-46s, three DC-4s and, finally, four Super Constellations (L.1049Hs). The Super Connies were delivered in April, 1958, and were put into service on the airline's Sao Paulo/Caracas/Miami/Chicago schedules in June.

For an airline that started with just one DC-3 in February, 1946, operating between Sao Paulo and Rio, a mere 225-mile route, the astounding growth and development of REAL—under the dynamic leadership of its Founder-President, Capt. Linneu Gomes—is almost certainly without equal in the international business of air transport. By 1954 they were carrying over one million passengers and by 1957 the two million mark was achieved, from the modest 47,000 in the first year of operations (1946). In passengers carried REAL now ranks 11th in the World's airlines, 17th on passenger miles flown and, finally, seventh largest in terms of aircraft fleet size.

It would indeed be tremendously interesting to know the background and circumstances which have finally resulted in REAL becoming a full member of IATA just over six months ago!

Nairobi. DENNIS M. POWELL, F.R.G.S.

Roundabout

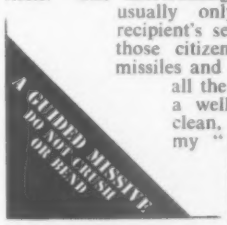
Curtain Up. First 1959 news of Treble-One Sqn., under the new management of Sqn. Ldr. Peter Latham, is that A.V.M. Alick Foord-Kelcey, new A.O.C. of 11 Fighter Group, has demonstrated his interest in this fine aerobatic team by flying with Flt. Lt. Paddy Hine in a Hunter T.7 for a "Big Nine" 13-minute practice show. It was the full treatment, including the new "Wine Glass" formation, and the A.V.M., who is 45 and thus old enough to be the father of some of the team's pilots, is also young enough to have enjoyed every minute of it. This is probably more than can be said for Flt. Lt. "Oakie" Oakford who, flying wing position to Paddy, was shaken to see, for the first time in two years, a helmeted face looking round at him instead of steadfastly watching "The Boss."

*

Tito on Nato. The above-mentioned rehearsal was for a show in aid of representatives of NATO, whose tenth anniversary is coming up. It reminds me that a diplomatic friend recently back from Belgrade says that Tito has been heard to call himself "an honorary member of the Nato Mess." I suppose the President *does* spell that last word with a capital "M"?

*

The Little Things. Three examples of American attention to publicity detail have just come my way from Lockheed. The first, from a Missiles Systems Divn. envelope, is reproduced here and speaks for itself. One shortcoming of this approach is that usually only the postman and the recipient's secretary see it. And among those citizens the demand for guided missiles and airliners is limited. Second, all the way from California comes a well-designed certificate, set in clean, modern type, a souvenir of my "Preview of *Electra/Flight*" at Gatwick during the Electra's world demonstration tour. I'm afraid a British company would have made an Olde Englyshe Scrypte and Scroll job of it, if they'd done it at all. Finally, a nice touch in naming the ski-equipped C-130 Hercules transport—the Ski-130. It figures.



*

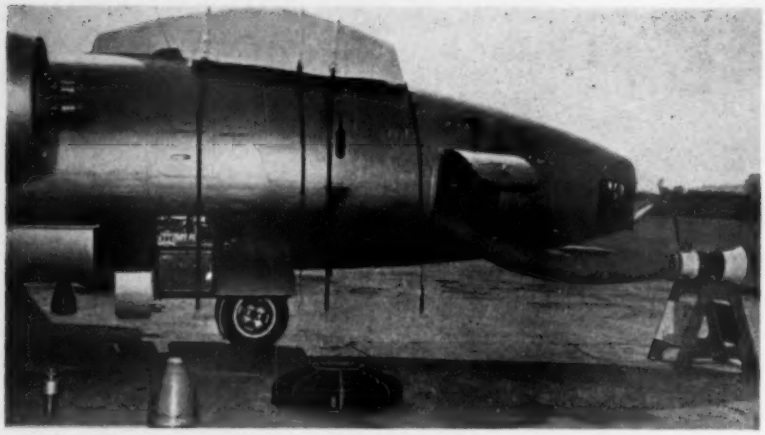
Life with Batchy. Atcherley stories are rife at the moment. Here's one about the time when, as C.-in-C. Flying Training Command, he arrived with a Staff Officer at one of his training airfields in a Vampire Trainer. An undercarriage leg folded up as he touched down and the aircraft settled noisily on its belly on the runway. The Duty Sergeant, in a Jeep, roared up alongside and shouted to the two helmeted occupants, who had raised the canopy, "Get this b— thing out of here—we're expecting the C.-in-C. any minute!"

*

"Of *course* there are too many people in the Corporation but the queer thing is that they are all in other departments."

by Gren

NOTES AND EVENTS



AIR VENTILATION.—To provide tolerable working temperatures during aircraft maintenance in tropical or near-tropical conditions, English Electric has developed a pressure cabin temperature control system specifically for Canberras. The system, which comprises an 8-in. Plannair axial-flow blower, a length of insulated air ducting equipped with fitted hood and a cockpit sun shield, is illustrated in position.

EXPANSION OF RANGE—The King Aircraft Corp., of Fifth Street, Hillington, Glasgow, S.W.2, has enlarged its range of products to cover advanced versions of its cam-lever, Senior and Junior, Arctic-type fasteners; twin bolt pipe clamp unit suitable for installation to 40° and 60° angle profiles; and other fastening and pipe coupling devices. The company has also introduced a range of reinforced plastic flexible hose assemblies in PTFE, PVC, and nylon materials.

HEAT TREATMENT. — Barlow-Whitney, Ltd., has introduced a new series of heavy-duty horizontal electric batch furnaces for all general heat-treatment processes such as annealing, normalizing, stress relieving, vitreous enamelling, hardening and tempering operations. There are two basic models—series E-HDF 950 for operating temperatures to 950°C. (maximum 1,000°C.) and series E-HDF 1100 for operating temperatures to 1,100°C. (maximum 1,150°C.).

PRODUCTION EXPANSION.—Recent increases in the demand for the sintered metal products of The Morgan Crucible Co., Ltd., have led to a move to larger premises. The sales office of the company has been moved to Wandsworth Works, Point Pleasant, Wandsworth, London, S.W.18, and a new factory and laboratory established there for the production and development of Sinterlink. This combines plant and facilities previously situated at Battersea, and Norton, Worcester.

BRITISH STANDARDS.—Two new aircraft Standards—L.76 : 1959. "Aluminium - copper - magnesium - silicon-manganese alloy billets and bars for forging and forgings. (Solution treated and aged at room temperature)" and L.77 : 1959. "Aluminium-copper-magnesium-silicon-manganese alloy billets and bars for forging and forgings. (Solution treated and precipitation treated)"—have been published by the British Standards Institution. Replacing L.64 and L.65 the new Standards cost 4s. each.

DESIGN APPROVAL.—Ketay, Ltd., manufacturers of synchros, resolvers, tachometer generators and other servo components, are now a design approved manufacturer under the Ministry of Supply instrument and electrical equipment design approval scheme. Four Ketay synchros have been granted certificates of technical approval following type testing to specifications approved by R.A.E.

ROTOL LICENCE.—Rotol, Ltd., which has recently become a member of the Dowty Group of Cheltenham, announces that a licence agreement has been completed with the General Electric Co., of Massachusetts. This agreement permits Rotol to produce hydro-mechanical constant-speed drives, utilizing ball-piston principles, under the patents held by the General Electric Co. This range of constant-speed drives is in large scale production in America and is being fitted to a number of aircraft.

SIMMONDS DEMONSTRATION.—A party of technical officers from the U.S.A.F., the Air Ministry, and M.o.S. and the major oil companies were at Treforest, Glamorgan, recently to witness a three-day series of demonstration tests on water separator equipment developed and manufactured by Simmonds Aerocessories, Ltd. The tests, which were undertaken at the Firth Cleveland fuel flow test house, were designed to show that the Simmonds equipment, a conversion unit for filter separators, complies with U.S. specifications and so is eligible for adoption by the U.S. Air Force in Europe.

Birth Notices

Alderdice.—On March 5, at Dunfermline Maternity Hospital, to Lynne, wife of Sqn. Ldr. N. G. Alderdice—a son.

Bradbrook.—On March 2, at R.A.F. Coltishall, to Anne (*née* Messer-Bennetts), wife of Flt. Lt. A. C. Bradbrook—a son.

Cox.—On March 8, at Cheltenham Maternity Hospital, to Susan (*née* O'Keeffe), wife of Sqn. Ldr. A. H. Cox, M.B., B.S.—a son.

Denney.—On February 25, to Sheila (*née* Chopra), wife of Flt. Lt. T. O. Denney—a son.

Ellis.—On March 5, at B.M.H. Rinteln, Germany, to Winifred, wife of Flt. Lt. E. Ellis—a daughter.

Furniss.—On February 19, to Denise, wife of Sqn. Ldr. P. Furniss, D.F.C., R.A.F., Legal Branch 7, Perth Walk, H.Q., R.A.F., Germany (2nd T.A.F.), B.F.P.O. 40—a daughter.

Hurrell.—On March 5, at Williamstown, Australia, to Jay, wife of Sqn. Ldr. F. C. Hurrell—a daughter.

Stoten.—On March 3, at R.A.F. Hospital, Wroughton, to Elizabeth, wife of Sqn. Ldr. D. L. Stoten—a daughter.

Aviation Calendar

March 25.—R.Ae.S. Southampton Branch A.G.M. in the Inst. of Education, University of **Southampton**, at 20.00 hrs.

March 25.—R.Ae.S. Preston Branch lecture, "The Application of Area Rule to Aircraft Design," by W. T. Lord (R.A.E., Farnborough), at the Queen's Hotel, **Lytham**, at 19.30 hrs.

March 25.—R.Ae.S. Weybridge Branch lecture (with the Southern Branch of the Inst. of Mech. Engineers), "Guidance and Control of Missiles," by L. H. Bedford (English Electric Co.), at the Apprentice Training School, Vickers-Armstrongs (Aircraft) Ltd., **Weybridge**, at 18.10 hrs.

March 25.—R.Ae.S. Bristol Branch A.G.M. and film show, at Filton House, **Bristol**, at 18.00 hrs.

March 25.—R.Ae.S. Graduates and Students Section lecture, "Aircraft Escape Techniques," by J. Martin (Martin-Baker Aircraft), in the library, 4 Hamilton Place, **London**, W.1, at 19.30 hrs.

March 25.—R.Ae.C. A.G.M. at 119 Piccadilly, **London**, W.1, at 18.00 hrs.

March 25.—Kronfeld Club talk, "Soaring and Cross-country Flying," by A. Goodhart, at 74 Eccleston Square, **London**, S.W.1.

March 26.—R.Ae.S. Southend Branch lecture, "Flying-boats," at the Labour Hall, Boston Avenue, **Southend**, at 19.30 hrs.

March 27-30.—Easter Gliding Rally, organized by Midland Gliding Club, at the **Long Mynd**, Salop.

April 1.—R.Ae.S. Gloucester and Cheltenham Branch, A.G.M. and film show, at the Wheatstone Hotel, **Gloucester**, at 19.30 hrs.

April 1.—R.Ae.S. Brough Branch lecture, "Flying with the Trans-Antarctic Expedition," by Sqn. Ldr. J. H. Lewis, in the lecture Hall, Electricity Offices, Ferensway, **Hull**, at 19.30 hrs.

April 1.—Kronfeld Club talk, "Field Landings and Retrieving," by Lorne Welch, at 74 Eccleston Square, **London**, S.W.1.

CABIN CLEANING.—A number of B.E.A. and Air France transports now carry their own vacuum cleaners, which makes them largely independent of airport cleaning facilities. These special portable machines are fitted with 28 v. motors and anti-static equipment. They are made and supplied by the British Vacuum Cleaner and Engineering Co., Ltd.

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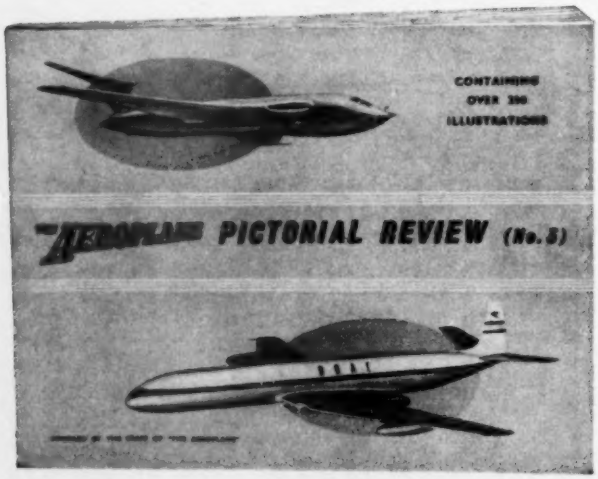

Compiled by the Staff of 'The Aeroplane'

THIS THIRD PICTORIAL REVIEW presents the most interesting photographs to have appeared in the pages of *The Aeroplane* during the past year. There are over 250 pictures grouped in eleven sections for ease of reference, and every aspect of civil and military aviation, including guided missiles and helicopters, is fully represented. The review of people and events of aeronautical interest is an added attraction of this new volume, and each photograph is accompanied by an informative caption.

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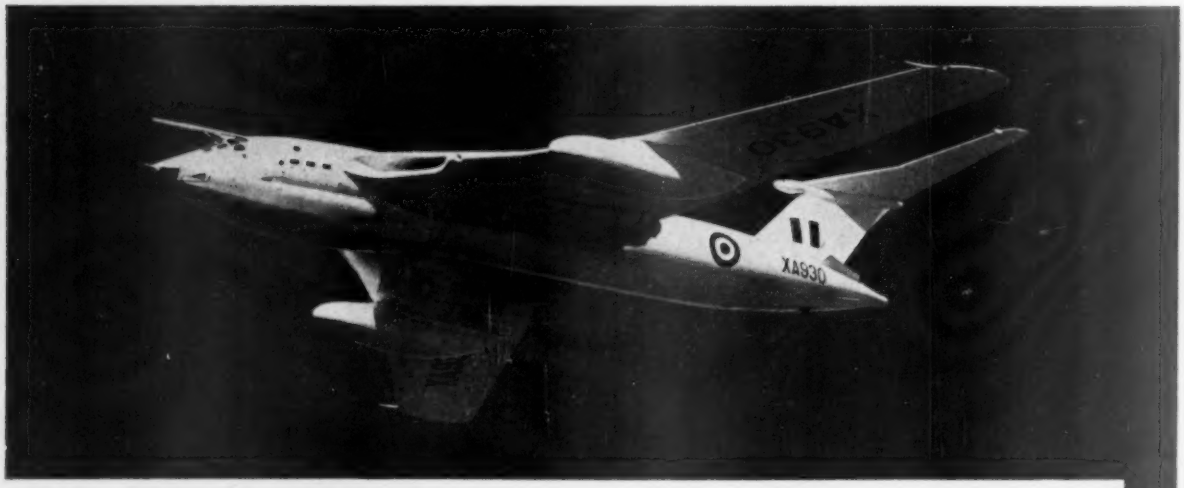

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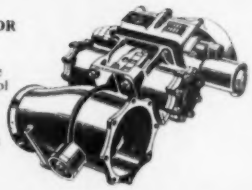

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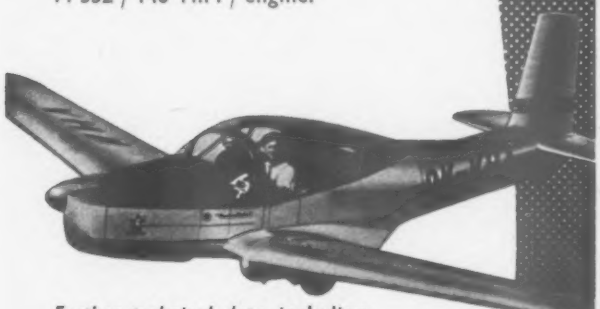

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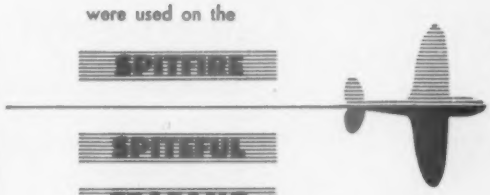

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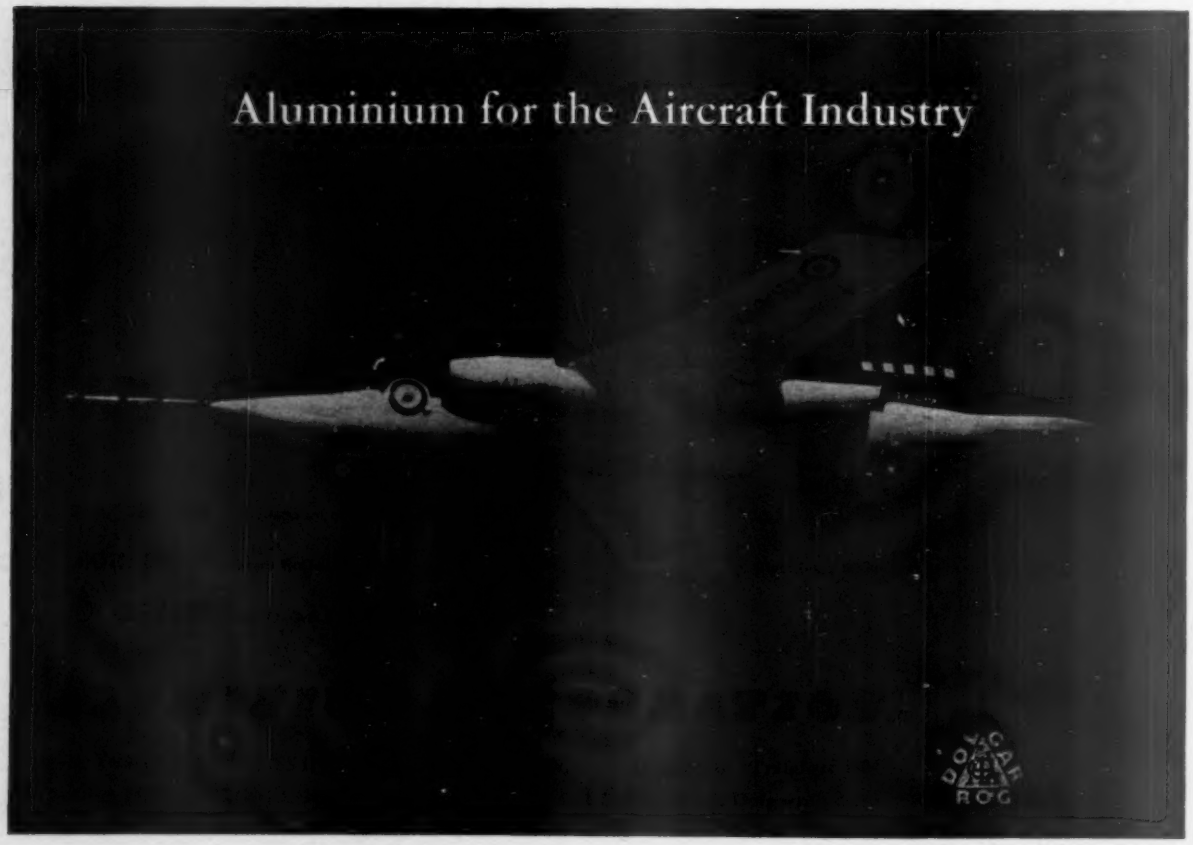

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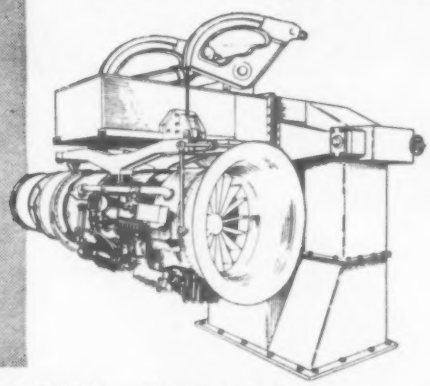

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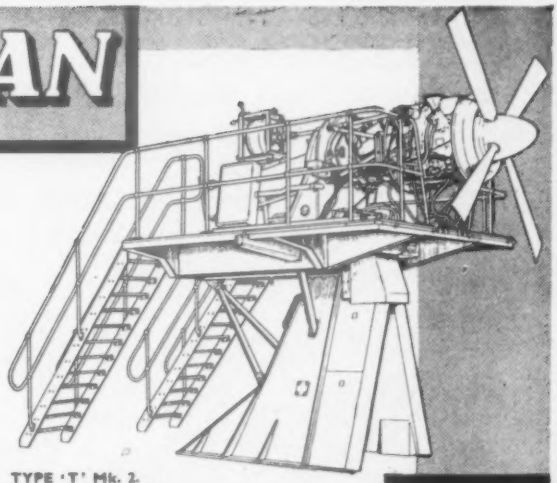

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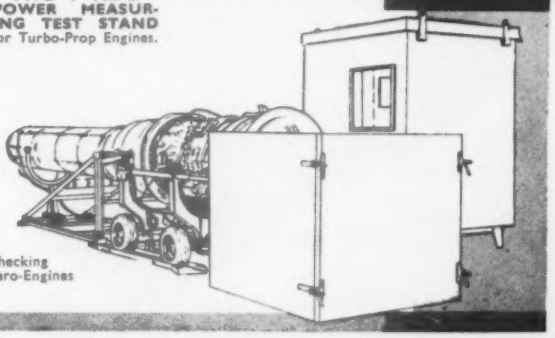

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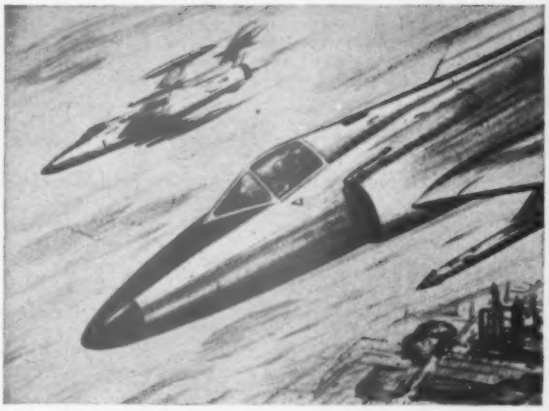

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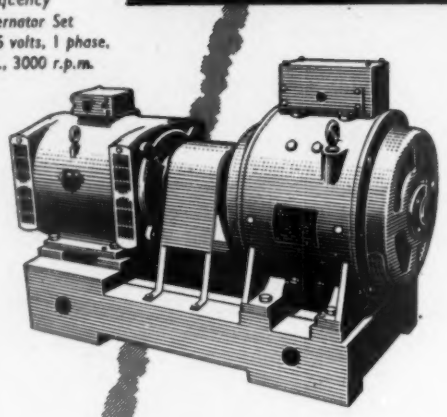

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FROM EAST ANGLIAN FLYING SERVICES, LTD., OF SOUTHEND AIRPORT, ESSEX:—

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These applications will be considered by the Council under the Terms of Reference issued to them by the Minister of Civil Aviation on July 30, 1952. Any representations or objections with regard to these applications must be made in writing, stating the reasons, and must reach the Council within 14 days of the date of this advertisement, addressed to the Secretary, Air Transport Advisory Council, 3 Dean's Yard, London, S.W.1, from whom further details of the applications may be obtained. When an objection is made to an application by another air transport company on the grounds that they are applying to operate the route or part of route in question, their application, if not already submitted to the Council, should reach them within the period allowed for the making of representations or objections. 481-2

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